DEPARTMENT OF COMMERCE

HERBERT HOOVER, Secretary

STANDARDS YEARBOOK

1927

Compiled by

THE NATIONAL BUREAU OF STANDARDS

GEORGE K. BURGESS, Director

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LETTER OF SUBMITTAL

DEPARTMENT OF COMMERCE,
NATIONAL BUREAU OF STANDARDS,
Washington, February 12, 1927.

SIR: I have the honor to submit herewith for publication the first issue of the Standards Yearbook, which will be brought out annually hereafter.

The Standards Yearbook represents an effort to present an adequate picture of the diversification and ramification of the standardization movement which has spread throughout the world with astonishing vitality during the 25 years that have elapsed since the establishment of the National Bureau of Standards. It contains outlines of the activities and accomplishments of not only this bureau and other agencies of the Federal Government and the States and municipalities, but also of the American societies and associations of which standardization is a major or very important activity. Descriptions and illustrations are presented of all the fundamental national standards of the United States. Moreover, outlines are given of the various foreign, national, and the several international standardizing agencies.

As a companion volume to Commerce Yearbook which deals strictly with industry and commerce, the Standards Yearbook deals strictly with standards and standardization. In this volume are correlated the essentials concerning standardization activities with which the Bureau of Standards is in close cooperation, and the subject of standardization is presented in its entirety.

The Standards Yearbook will be most valuable in the daily work of all officers and agencies concerned with standardization, especially in its official or governmental aspects. It will furnish the answers to a great volume of urgent inquiries received by the Bureau of Standards from manufacturers, industrial experts, engineers, and purchasing agencies both governmental and general.

Respectfully,

GEORGE K. BURGESS,
Director Bureau of Standards.

HON. HERBERT HOOVER,
Secretary of Commerce.

CONTENTS

STANDARDS YEARBOOK, 1927

I. TREND OF STANDARDIZATION

Standardization is the oustanding note of this century. It ramifies to the remotest details of our industrial régime. Its trends are highly significant. They tap all sources of scientific knowledge and affect every phase of design, production, and utilization.

1. The trend is away from mere opinion, or even expert judgment, and toward verifiable determinations by research of those quantities or properties which assure maximum utility. This affects quality at its source, in the design of the product, or the layout of the process by which it is produced.

2. The trend is away from mere duplication of material once found acceptable, away from mere "brand" designation, still further away from mere descriptive or qualitative prescription. The trend is toward a precise statement in measurable terms of the magnitudes of the pertinent dimensions or properties which determine the utility.

3. The trend is toward a minimum of standards of quality, perhaps a single national or even international standard, for each service to be rendered, each need to be met. With precise methods of arriving at the data comes the natural unification of specifications, the reduction in their number as they approach ideal measures of the quality desired, as science and service make possible, and as the size of the groups interested in a given specification widens.

4. The trend is toward making standardization an active principle in organization and administration in every field. This is evidenced by the multiplication of standardization agencies organized, including technical committees on standards in the great national professional societies. Standardization is becoming an aspect of all well-ordered activity rather than an incidental activity supplemental to others.

5. The standardization procedure itself is becoming standardized gradually. A set of principles of practice is slowly forming as to the initiation, sponsorship, participation, technical basis for requirements, criticism, revision, adoption, jurisdiction, promulgation, and adherence. As the scientific basis for such procedure becomes more convincing, acceptance by wider jurisdictions becomes relatively easier and standardization is accelerated on a broader basis of acceptance.

6. The boundaries of the standardization field are expanding and the prospect is that it will soon cover systematically all industry and

science, securing the full cooperation of all concerned, focusing every pertinent knowledge on each item standardized, feeding back service experience to the standardizing agencies, adopting the presumptively best feasible, making it a general standard. The standardized post-card serves the Nation acceptably for billions of communications annually. Modified if utility dictates, it may serve for the entire world.

7. Standardization of all degrees is universal in industry. The entire output of industry, the processes, and machines are being standardized, some by individuals or firms, others by technical organization, still others by the users. Many are being standardized by the Government. Naturally there is no natural limit to standardization, and the benefits to be secured from the perfected service of well-standardized products are immeasurable. Most of all, standardization has become recognized not as a stage to be completed but as a continuing process—literally a systematic harvesting of experience and discovery used in perfecting industry. The Government program of standardization of quality through specifications must eventually include at least all articles and services used by the Government. The trend is to cooperate for the broadest jurisdictions, and this points toward national standards assuring the best feasible products for the Nation.

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There is everywhere intense activity in standardization through older organizations and through newer agencies, both national and international. Nor is such activity limited to the industrial field. In science, terminology, methods, instruments, constants are being standardized for ease and speed of diffusion of data and to secure comparable results. In medical research and practice measured procedure is increasing in diagnosis and treatment. The trend is notable—the struggle for new standards based on new experience, new knowledge—innovation winning through merit. Always the chaotic, chance qualities and sizes give way to orderly, efficient qualities and sizes. Evolution shows the development of standard types of life forms adapted to a given environment. Even the fine arts bear the impress of standards—the metrics of verse, the rhythm of ornament and motion, the proportions of structures. The interplay of standards is seen in unsuspected fields where their rôle is mandatory, sometimes with a rigor superior to legal enactment.

Since 1901, when the Bureau of Standards was founded, the varieties of measurement have multiplied manyfold. Each requires units, standards, methods of measurement. Their variety grows rapidly and will continue to grow, for every aspect of matter and energy calls for a type of measurement with characteristic problems and becomes material for standardization. Our mastery of nature depends on

such measurements. Precision to-day may be many times that of 25 years ago within ranges then measurable. To-day we measure wave lengths of light to within one two-hundred-and-fifty-billionth of an inch, mass to a part in a billion. We rule scales accurate to a millionth of an inch, grind quartz true flats to within one five-millionth of an inch. Not only so, but the measurable ranges of each kind of measurement have been extended incredibly, to infinitesimals—the diameters of atomic nuclei, and to magnitudes ten or more million light years.

With the rapid growth of measurements, their varieties, ranges, and precision, we now measure quality or fitness for use, performance, or utility of devices, practice, or effectiveness of processes. These call for standards of quality, performance, or practice—complex, perhaps, but stating in measurable terms the pertinent magnitudes which determine net utility. They are called specifications. As they approach definiteness through precise measures they become service standards. Their full scope covers all of industry when scientifically ordered, for measures must guide every step, every factor in making or doing things, to insure their utmost utility.

When a Federal, State, or municipal government, or a corporation buys commodities, the quantities involved forbid risk of poor quality. The demand must not be impracticable, hence to secure a product producible in the mill and usable in service all concerned must be consulted—maker, seller, buyer, user. A typical case of this was in formulating the Federal specifications for electric lamps in 1907. This was drafted in conference with Government lighting experts, lamp buyers, representatives of makers and sellers, and bureau experts in photometry. The great variety then in use was promptly simplified to a moderate number adequate for all needs. The specification has been revised nine times as progress has made possible, with the joint approval of all. Its provisions are feasible mill practice; the bureau inspects at the mills to minimize cost and delay, and the lamps accepted under the specifications serve their purpose effectively. To-day the Government specifications apply to the entire American public largely because all concerned are parties to their formulation and revision. A similar story may be told of Portland cement.

While service is the ultimate test of fitness, production must precede service. The designer and the producer must use the skill and data at hand, for the buyer is waiting in the market. As a basis for purchase, sale, and use standards are drafted with all degrees of thoroughness, loosely at first, definitely as knowledge permits. The cycle begins empirically, the expert drafting a tentative specification in such terms as the mill may be able to apply to making the product. As the public must pay, its voice must be

36316—27——2

heeded, but the public is less concerned with the details of the measurements which assure such quality.

Research is the vital factor in standardization chiefly through seven lines of approach: (*a*) Measuring the need to be met, (*b*) analysis of factors adapted to meet the need, (*c*) fixing measured controls for production of predictable quality, (*d*) basing such controls on correlation of fitness factors with service utility, (*e*) devising methods of test of quality, (*f*) analysis of service experience or simulated service to aid in improving the standard, (*g*) most important—research fundamental to the pure sciences involved.

The measures of the need are the matrix for the specification. Point by point the measured quality must match the measured need. The measured curvature of the lens is made to match the measured defect of the eye, and the result is perfected vision. The measure of the need is basic. Modern science is making it possible not only to measure every need, but to create new desires and needs for the enrichment of life—aviation, radio, the camera are examples. Fitness for use is the definition of quality. Fitness can be assured only when the need to be met is scientifically measured. Such measures must be the basis for all standardization.

Research thus affects every phase of the choice, treatment, and use of materials and energy, specifically through the discovery of correlations of the properties of matter and energy with useful service to man. In commerce the properties of materials are, of course, the real utilities sold, bought, and used. The utility of things depends upon the nature, magnitude, and stability of these properties. To determine these is the purpose of research, to correlate them with their uses is its main problem. By eliminating the useless or harmful properties and developing the magnitude of useful properties, the net service is enhanced.

Standards are the means by which research is applied to the production of serviceable things. There is a best standard humidity for cotton spinning, a best compression ratio in the motor, a best volatility curve for a gasoline, a best diameter for a conductor for a given current avoiding both overheating and undue cost. These are matters of standardization. They are its principal task. They can not be fixed by service experience for the ideal value may not, usually does not, occur in experience. It occurs as a matter of course in experimental research which measures the effect of each factor and finds by experiment the maximum and optimum. Research is the appeal to the nature of things. Its findings must, through standardization, enter into the control of the processes of industry to serve man. Congress gave the National Bureau of Standards the task, among others, of measuring numerical constants which express the behavior of matter and energy. They are unlimited in number,

they inhere in the nature of things, and their accuracy is their sole merit. They are indispensable in planning the processes of science and industry and become a permanent service element in industry, playing their part no less than the tool or the power. Dimensions are important, but the measure of properties is now quite as important and exacting as control of size, and far more productive of new and superior kinds of service. Such constants are as essential to the functioning of a process as the size and form of a key to the opening of a lock. Research has a field in devising tests which can only be mentioned here. Perhaps the test may be regarded as a temporary expedient until the standardized process makes the quality inevitable and never failing. Then, with all factors of the productive process standardized, the process will unfailingly deliver uniformly high quality and exact dimension.

Service research, hitherto somewhat random, is becoming recognized as the true complement of laboratory research in completing the standardization cycle. Research discloses facts which service alone can not reveal. It finds faults in materials, defects in devices, imperfections in service. It finds their cause and cure. It does far more, for it lays down new principles of nature which permit progress not only by steady increments along old lines, but by entirely new methods creates new possibilities.

With active cooperation between maker, seller, user, and the research laboratory the specification becomes a means of steady progress in the industry concerned, and combined with service experience facilitates the more efficient adaptation of materials to their uses. Inflexible specifications or standards retard advance, but if allowed to grow apace with new service experience and research data, the specification becomes a distinct aid to such progress. Standardization in the nature of the case implies something of an ideal, a practical ideal it is true, but nevertheless an ideal. When it ceases to be such an ideal it ceases to be true standardization and becomes simply fixation.

Research takes service experience, analyzes it, and gives the data to the standardizing agencies as helpful in revising the specification. Service integrates all factors determining net utility. Use is the dictator, hence the appeal to service is logical. Service can tell the whole story. An excellent example is the test structure erected by the Bureau of Standards in which 50 or more varieties of outdoor stuccos were built into separate panels, each of one variety. The weather alone performed the test, the conclusions were obvious—the fittest survived. Poor types were removed from the market. Without debate a steady progress in the quality of market stuccos resulted from this service experience made available in a carefully planned investigation.

Wise industrial groups may anticipate the users' desires, even educate them to ever higher standards of service demands. Twenty million car owners may not be able to give the knowledge for designing an ideal car, but their desires create a channel along which effective design may well flow. Service experience, however, must yield far more than opinions of users, namely, the scientific analysis of the service itself, measured as carefully as we measure the parts of a machine. Hence "tire-miles," "car-miles," "miles per gallon," "cents per mile," "watts per candle," and the like are shop parlance where service efficiencies are in daily question. Service efficiencies must be measured and the data used in revision. Service experience, viewed in the light of the laboratory tests, must, however, be the criterion for judging the adequacy of the specifications themselves, or their need for improvement.

More and more through research the most effective dimensions and measures are wrought into materials and devices. The standards of control measurements are less and less subject to opinion or even expert judgment. Experts recognize that the day of arbitrary opinion is passing, that experimental research and service experience can best guide every item of the standard. With great gaps in our precise knowledge of the properties of matter and energy, empiricism still rules, but its domain narrows as research gives us measured data based on scientific methods.

No standardization is final since science is always advancing and more effective equipment is steadily introduced into industry. The specification should be improved by steps not too frequent to unduly interrupt the course of industry and trade, but often enough not to lose the great gains from prompt use of new knowledge. Standardization is a continuing process. Its aim is not fixity or stagnation, but to add serviceability as often as the potential gain makes it worth while.

II. INTERNATIONAL STANDARDIZING AGENCIES

The exigencies of international commerce, navigation, travel, and diplomacy have necessitated certain standardization activities designed to fix such fundamentals as time and chronology, latitude, and longitude, common bases of reference in which to fix the values of monetary units, quantities, tonnage register, the depths of the navigable waters, draft of vessels, positions of the stars and planets, national boundaries, and many similar essentials of human activities. A very brief statement concerning some of the international organizations having charge of these subjects as they effect standardization will be given. The nongovernmental agencies are so numerous as to preclude description. At first the agencies were largely scientific and technical groups meeting in convention and agreeing upon matters which then became subjects of legislation or administrative adoption. The first to be organized for the preparation and distribution of standards was the International Bureau of Weights and Measures.

GOVERNMENTAL

INTERNATIONAL BUREAU OF WEIGHTS AND MEASURES

[Sèvres, near Paris, France]

The International Bureau of Weights and Measures was established by the Metric Convention of May 20, 1875. This famous treaty was signed at Paris by the plenipotentiaries of most of the leading occidental nations. This bureau has the custody of the international standards of weights and measures—the meter and kilogram—to which all prototypes of the world are referred for verification. The bureau is maintained jointly by the contracting States, now numbering 29. The international bureau is located in the Parc de St. Cloud, Sèvres, in the northwest suburbs of Paris, on neutral territory ceded by France for this purpose. The work of the bureau is supervised by an International Committee of Weights and Measures, which is itself supervised by a general conference of weights and measures provided for by the treaty of 1875.

Under the terms of the treaty the general conference meets at least once in six years to discuss and initiate measures necessary for the dissemination and improvement of the metric system, and to pass upon fundamental metrological determinations. The conference is thus the highest administrative body for international action on weights and measures, being supported by the 29 nations

now adhering to the treaty. Under it functions an International Committee on Weights and Measures, whose work is to supervise the International Bureau of Weights and Measures.

The Nations now adhering to the metric treaty signed May 20, 1875, are the following:

Germany, United States, Argentina, Austria, Belgium, Brazil, Bulgaria, Canada, Chile, Denmark, Spain, Finland, France, Great Britain, Hungary, Italy, Japan, Mexico, Norway, Peru, Portugal, Rumania, Russia, Serbia, Siam, Sweden, Switzerland, Czechoslovakia, and Uruguay.

These nations are officially represented in the International General Conference on Weights and Measures.

Following is a digest of a report of the activities of the bureau September 1, 1923, to August 31, 1925, read at the session of the International Committee on Weights and Measures, September 22, 1925.

President V. Volterra recalled that May 20, 1925, marked the fiftieth anniversary of the bureau. Despite unfavorable conditions the level of work has been maintained with confidence that the governments will provide resources sufficient for the task. A representative of the National Physical Laboratory (England) was given the use of the facilities of the bureau to determine two standards of length, and a representative of Canada aided in like comparisons, both of which disclose unexplained apparent changes in length, as high as a micron for the Canadian standards.

The discrepancy in the absolute expansion of standard bar II_4 of the Central Chamber of Weights and Measures of Russia (compared with 1910 determination) has been reduced sensibly.

The precise determination of the mural base is fundamental for geodesy, but this determination compared by primary wires occupied the bureau five days without giving all the certainty desired. The need for a new base was met by a contribution from the Internationa Education Board. The sum was turned over to the Geneva Society (Société Genevoise).

By action of the International Committee a microphotographic equipment has been installed. Mr. Johnansson, of Eskilstuna, Sweden, has retouched certain standards of plane and parallel faces, making them almost perfect.

The only prototypes which have been received at the bureau for test during the past two years were those of Finland, meter No. 5 and kilogram No. 26. These have been returned, as well as the German meter No. 18 and Norwegian meter No. 3. Meter No. 26, belonging to the Conservatoire National des Arts de Metiers, has been returned to the bureau.

Experiments show how complex is the problem of using light waves as standards of length. Perard has examined many types of

lamps of cadmium. Through the courtesy of Mr. Tanakadate, the bureau has received a lamp of the Nagaoka-Suguira type which functions at 200 volts. The red rays of cadmium remain remarkably monochromatic and interference fringes appear very sharp even for 200 millimeters difference of path. The comparisons of wave lengths have assumed great importance.

Two measurements have been made of the length of the base, one at the end of 1923 and one in the spring of 1925. The work is long and laborious and will be simplified in the future. With the geodetic comparator a study was made of the Spanish geodetic standard including a calibration by comparison with the bureau's standards, then in determining the decimeter intervals for the first meter of the bar, which necessitates standardization of the invar 1-meter bar.

On authority of the committee the director of the bureau reported that he had taken from the vault the prototype meter No. 1 and kilogram No. 7. Kilogram No. 7 replaces provisionally kilogram No. 1. Both will be restored to the vault. The committee unanimously decided that kilogram No. 7 should not be touched until the conference had decided with reference to the replacement of kilogram No. 1 by this kilogram as representing the international kilogram.

INTER-AMERICAN HIGH COMMISSION

[Washington, D. C.]

This commission has prepared (in cooperation with the Department of Commerce) pamphlets giving specifications for various commodities. These have been distributed to the Latin-American members. Preparations are under way for the Conference on the Standardization of Specifications to be held at Washington in May, 1927. Further data can be had from the Washington representative, J. Homer Butler, room 620, Hurley Wright Building, Washington.

NONGOVERNMENTAL

INTERNATIONAL ASTRONOMICAL UNION

[Imperial College, London, SW. 7, England]

The International Astronomical Union (formerly the International Union for Solar Research) is composed (July 14, 1925) of member organizations representing 22 countries as follows:

Australia, Belgium, Brazil, Canada, Czechoslovakia, Denmark, France, Great Britain, Greece, Holland, Italy, Japan, Mexico, Norway, Poland, Portugal, Rumania, South Africa, Spain, Sweden, Switzerland, and United States.

The president (1925–1928) is Prof. W. De Sitter, Starrewecht, Leiden, Holland.

The secretary is Lieut. Col. F. J. M. Stratton, Gonville and Caius College, Cambridge, England.

The standardization activities affect not only the pure science of astronomy, but the arts of navigation, chronometry, and chronology, the establishment of boundaries between States and nations, and the determination of location in geodetic surveys and exploration. Prof. W. W. Campbell at the last meeting of the union said:

> If one is looking for the practical side of astronomy he can find it; astronomers tell the shipmaster how to reach his destination on the other side of the ocean; they supply accurate time by wire and wireless to all who are prepared to receive their signals; they have been known to run boundary lines between nations (when they have been asked to do so), perhaps nowhere more successfully than between the United States and the Dominion of Canada.

The standards of the union are chiefly through the following of its committees: Notations, ephemerides, astronomical telegrams, meridian astronomy, astronomical instruments, solar physics (joint program), length of light waves, lunar nomenclature, longitude, variation of latitude, map of the heavens, stellar parallaxes, stellar photometry, commission on the hour.

The following was adopted at the 1925 meeting as "provisional specifications for producing a primary standard of wave length":

> The primary standard of wave length, 6,438.4696 of cadmium, shall be produced by an electric current of high voltage in a vacuum tube bearing interior electrodes. The lamp shall be maintained at a temperature not exceeding 320° and shall give differences of path of at least 200,000 wave lengths. The effective excitation current shall not exceed 0.05 ampere. At room temperature the tube shall not be luminous when it is connected to the usual high-tension circuit. (See Transactions of the International Astronomical Union, vol. 2; 1925.)

The union aims to facilitate the relations between astronomers of different countries where international cooperation is necessary or useful, and promote the study of astronomy.

The admission of any country to the union is subject to the regulations of the International Research Council. A national committee is formed in each member country under the responsibility of the principal academy or its National Research Council or other responsible body.

A general assembly of delegates directs the work of the union standing committees, studies and plans collective research, and discusses standardization. The unit used in wave-length measurements of radiation and spectroscopy, in general, is the international Ångstrom. The union now defines this unit basically in terms of the cadmium red radiation, the wave length of which is described under the chapter on standards in this yearbrook (see Spectrometry), in accordance with the equivalent found by Michelson, Fabry, and Perot and Benoit for the length of the meter in terms of cadmium red wave lengths.

INTERNATIONAL COMMISSION ON ILLUMINATION

[Teddington, England]

The international commission was formed in 1913 by reorganization of the former International Photometric Commission to provide a coordinating agency through which knowledge of lighting art might be promoted in all countries within the sphere of its influence. While primarily an agency for international standardization, it concerns itself with practical problems of improved lighting conditions through its several national committees. Dr. Edward P. Hyde is president, and C. C. Paterson, honorary secretary and treasurer.

Summary of principal decisions [1] *at the sixth session (July, 1924) at Geneva*

1. The following is recommended as primary standard of light: The brightness of a black body, used under precisely defined conditions.

2. Recommended that the national laboratories take steps (*a*) to formulate standard definitions for constructing and conditions for using a black body as primary standard of light; and (*b*) to establish the definite value of the brightness of a black body used under these conditions expressed in international candles per square centimeter.

3. That a subcommittee be formed to study the terminology of lighting.

4. That definite values (given) be used provisionally for the factor of visibility (for certain specified wave lengths).

5. That the committee on heterochromatic photometry extend its study to include the properties of absorbing screens.

6. That a committee on colorimetry be formed.

7. That certain symbols and definitions (listed) be adopted (comprising 8 symbols, 15 definitions).

8. That the next session include one meeting devoted to the lighting art and its popularization.

9. That the lighting of public streets be the subject of another meeting at the next session.

10. That the report of the committee on the study of lighting of factories and schools at the Geneva (1924) session be adopted in regulation of such lighting, with the reservation that the words "minimum recommended" be inserted in place of "minimum prescribed."

11. That further steps be taken to draw attention to the need for rules and regulations relative to lighting from the point of view of hygiene and of safety in factories and schools.

12. That the national committees begin at once the study of the question of automobile headlights.

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[1] "Commission Internationale de l'Éclairage, Sixième session, Genève, Juillet, 1924—Recueil des Travaux et Compte Rendu des Séances."

13. That if an international conference is called by any government for the purpose of regulating traffic or lighting of automobiles, the International Commission on Illumination desires to be invited to participate in the work concerning lighting.

The following committee reports and memoirs were submitted:

1. Primary standard of light following the proposal of Waidner and Burgess.
2. Realization of a primary standard of luminous intensity.
3. Standards of light suitable for sensitometry.
4. Properties of tungsten and the characteristics of tungsten lamps.
5. Fittings for lamps for photometry.
6. Definitions, symbols, and nomenclature for photometry.
7. Heterochromatic photometry.
8. The color temperature and luminous efficiency relation for tungsten.
9. Use of absorbing screens in heterochromatic photometry.
10. Relative visibility function.
11. Practical illuminating engineering.
12. Furtherance of good lighting by American central stations.
13. Demonstration method of teaching good lighting practice.
14. Street lighting.
15. Lighting of public streets in Paris by gas and by electricity.
16. New signal systems applied to the regulation of traffic in cities (the luminous sign and the lighting of tenements).
17. Lighting in factories and schools.
18. Industrial lighting developments in England.
19. Phenomena of glare.
20. Automobile headlights.
21. Standard specifications for headlight control and the reason for their adoption.
22. The field for international agreement and standardization in illumination.
23. Photometry of automobile headlights.

INTERNATIONAL ELECTROTECHNICAL COMMISSION

[28 Victoria Street, Westminster, London, England]

The International Electrotechnical Commission was organized in 1906, an outgrowth of a resolution adopted by the International Electrical Congress of St. Louis, in 1904, to the effect that steps should be taken to secure the cooperation of the technical societies of the world by the appointment of a representative commission to consider the question of standardization of nomenclature and rating of electrical apparatus and machinery.

The organization meeting was held in London June 26–27, 1906, at which time delegates from 14 nations were present. Lord Kelvin was the first president, Col. R. E. Compton, honorary secretary.

Each country joining the commission forms a national electrotechnical committee, through its technical societies which deal primarily with electrical and related subjects. In a country having no such technical societies the Government may appoint the committee. In the United States the national committee was organized in 1907 by the American Institute of Electrical Engineers, and it is known

as the United States National Committee of the International Electrotechnical Commission. The office of the United States national committee is at 33 West Thirty-ninth Street, New York, N. Y.

The affairs of the commission are handled through a council consisting of the president of the commission, the presidents of the national committees, ex officio, and one delegate from each national committee, with the honorary presidents and secretaries of whom there are several. At present the commission comprises 26 national committees. Meetings of the council or commission may be called by the president or at the request of three countries. The commission is supported by funds contributed through the national committee of the adhering countries on a basis of population and export trade. Meetings are of two kinds, meetings of the advisory committees of the commission and plenary meetings. There are advisory committees on a number of technical subjects, such as insulating oils, standard voltages, symbols, prime movers, international vocabulary, and several other subjects. The advisory committees are composed of representatives from the national committees formally interested in the subject. After agreement has been reached in an advisory committee, the committee report is acted upon at a plenary meeting of the commission.

The commission has issued numerous reports during the past 20 years, among which are the following international standards:

27. International Symbols, part 1, Letter Symbols (September, 1913).
28. International Standards of Resistance for Copper. (September, 1913).
29. Prime Movers for Electrical Plant (September, 1913).
30. I. E. C. Rules for Electrical Machinery, volume 1 (October, 1919).
38. International Symbols, part 2, Graphical Symbols (April, 1926).

The last plenary meeting was held in New York in April, 1926; the next meeting will be held in Rome in the fall of 1927.

At the April, 1926, meeting of the commission 16 countries were represented by about 120 delegates. The committees reported activities as follows:

Nomenclature.—One of the most difficult and important matters is an international electrotechnical vocabulary. The establishment by the commission of an electrical vocabulary will secure for the engineer the unity and stability essential to a clear comprehension of the literature of all nations. Vocabularies were obtained from Holland, France, Italy, and England. A plan of action was adopted.

Rating of Electrical Machinery.—This committee has been functioning for several years, during which time it has effected a unification of regulations in several countries for generators, motors, and transformers. The subject touches industrial and commercial questions. The committee has thus arrived at an international specification for electrical machines, the importance of which is

obvious. The committee unanimously reached a decision on the methods of measuring the internal heating and the classification of insulation.

Symbols.—This committee's previous publication, No. 27, contains the letter symbols (notation) of the fundamental units of electrical quantities, and various mathematical symbols and rules for abbreviating metric weights and measures was amended by the adoption of Ω as the symbol and abbreviation for the term "ohm." At the New York meeting the committee established a long list of graphical symbols for heavy-current electrical installations, including graphic symbols for electric traction. The subcommittee on symbols for telegraphy, telephony, and radio has prepared lists of symbols for submission to the various national committees.

Prime Movers.—Two subcommittees formed to consider hydraulic turbines and steam turbines submitted reports which have been adopted unanimously by the advisory committee.

Lamp Bases and Sockets.—The plenary meeting adopted certain dimensions as to the international standard for bayonet bases and sockets. The dimensions were those proposed by the French and British. Agreement on the subject of bases and screw sockets is nearly reached.

Voltages.—The plenary meeting adopted a list of voltages by the use of which the distribution net works may interfunction on voltages specified therein. These comprised standard voltages as consumers low terminals, nominal mean values of transmission line voltages, and definitions of nominal and maximum and minimum voltages.

Traction Motors.—The plenary meeting adopted a specification for traction motors subject to the approval of two points by the French committee.

Insulating Oils.—The task of this committee is the unification of the tests of insulating oils. Many determinations have been made in various countries, but many still remain to be undertaken to provide the data needed by the committee. Five recommendations as to tests were adopted by the plenary meeting.

Rules and Regulations of Transmission Lines.—The necessity of transmitting electrical energy at high potentials over great distances has led to the creation of aerial distributing lines. To protect the public against accidents, legislative bodies have issued regulations relative to their construction. A report containing five propositions was adopted by the plenary meeting.

INTERNATIONAL STANDARDS ASSOCIATION

[Organization pending]

Following the proposal to organize an International Standards Association, the national standards committees of the several countries were furnished with a draft of a proposed constitution

(statutes and by-laws) based on those of the two leading similar organizations. The main committee of the American Engineering Standards Committee, through its secretary, has received approvals (some with reservation of final approval or conditionally) from the following:

Australian Engineering Standards Association, Austrian Standards Committee, Belgian Standards Committee, British Engineering Standards Association, Canadian Engineering Standards Association, Czechoslovakian Standards Committee, Danish Standards Committee, Dutch Standards Committee, Finnish Standards Committee, Italian Standards Committee, Japanese Standards Committee, Norwegian Standards Committee, Polish Standards Committee, Russian Standards Committee, Swedish Standards Committee, and Swiss Standards Committee.

The purpose of the association is stated to be the interchange of information on standardization work and activities; promotion of uniformity among national standards; approval, ultimately, of international standards, after sufficient experience has been acquired; and extension or modification of machinery for these objects.

INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY

The union was organized in London, June, 1919. Its name indicates its scope, and the following committees outline clearly the nature of its specific activities, most of which directly lead to standardization.

1. Committee on chemical elements (president, G. Urbain), prepares and publishes the official international tables of atomic weights, mass numbers of isotopes, constants of radioactivity.

2. Committee on the nomenclature of inorganic chemistry (president, W. P. Jorissen).

3. Committee on organic chemical nomenclature (president, A. F. Holleman).

4. Committee on biochemical nomenclature (president, Gabriel Bertrand).

5. Committee on physiochemical standards (president, E. W. Washburn).

Under the auspices of this committee a bureau of physiochemical standards is maintained at the University of Brussels under the direction of Prof. Jean Timmermans.

6. Committee on standard analytical reagents (president, A. Kling).

7. International annual tables of constants and numerical data of physics, chemistry, and technology (general secretary and editor, Charles Marie).

This publication is issued annually and reproduces in each of its volumes all numerical data published in the literature of the world during each year.

8. Committee on physiochemical symbols (president, E. Cohen).

9. Committee on solid fuels (president, M. Huybrechts).

10. Committee on liquid and gaseous fuels (president, Georges Gane).

11. Committee on ceramic products (president, G. Capsa).

This committee has prepared and distributes a standard sample of zettlitz kaolin. Samples of this material can be obtained by addressing the National Bureau of Standards.

12. Committee on bromotology (president, Orla Jensen).

13. Committee on scientific and industrial property rights (patents and copyrights) (president, Prince Ginori Conti).

14. Committee on industrial hygiene (president, Charles Lormand).

15. Committee on the establishment of a thermochemical standard (president, W. Swietoslawski).

At the meeting of the council June 24, 1925, at Bucharest, Rumania, the Commission on Tables of Constants decided (*a*) That it considered particularly important the official adhesion of Chile, Japan, and Switzerland to the union and the inclusion of the corresponding apportionments in the budgets of these countries; (*b*) that the union believes it desirable to give the committee on annual tables the maximum security, the official adhesion of all countries being the ideal solution; (*c*) that the union requests the International Research Council to call a meeting of the international conference in which a definite statute concerning the committee on annual tables shall be established and the adhesions officially registered.

Commission on Pure Products for Research Analytic Reagents.— It was decided to establish for each reagent and for each pertinent impurity that the reagent may contain, a table of minimal quantities of such impurity that the current analysis permits. The tolerance of impurity shall be expressed in milligrams per 100 grams of the product.

The type of code to be adopted for defining a reagent shall carry the precise indication of the author's reasons therefor based on researches, related to such and such value of the sample taken for test, of the quantities of the reagents added, of the conditions under which the research has been conducted, in a word, the project for a code should be formulated in the smallest details, the operations effected, as well as the purpose, in order to permit a useful criticism on the part of all the members of the commission.

The choice of maximum tolerance to be allowed in such or such analytical reagent should be guided by the consideration of the mass of this impurity which may be introduced by the maximum quantity of this reagent in the course of an analysis and also the consideration of the industrial cost of the purification of the reagent in question.

Standards of benzoic acid made by Maison Poulene have been compared as to heat of combustion with that of the same acid of the

Bureau of Standards chosen as an international primary standard. They proved practically identical. Similar comparisons with the standards of other laboratories will permit the direct reference to the secondary standard.

The establishment of a series of standards of viscosity led to the undertaking of a critical experimental study of the conditions to be realized in order to make exact measures by the aid of the Ostwald viscosimeter. This work, by M. Martin, furnished interesting results (see Bulletin de la Société Chimique de Belgique, vol. 34, pp. 81 to 116, February, 1925). We now possess at the disposition of our colleagues a series of four standard products which assure a concordance of at least 1 per cent in the measure of viscosity made in the various laboratories (between 250 and 2,000 cgs units). The study of other standards has now been continued, notably refractometry, the research requisite being the subject of communications in the Journal de Chimie Physique.

International Commission on the Chemical Elements (Paris, France).—The International Commission on the Chemical Elements is the first of the committees maintained by the International Union of Pure and Applied Chemistry. Its president is M. G. Urbain (1 Rue Victor Cousin, Paris, France). The second report of the international commission contains the International Table of Atomic Weights for 1925, with details concerning the changes made according to the rules adopted to govern changes. The office of the general secretary is 49 Rue des Mathurins, Paris, France.

International Bureau of Physicochemical Standards (Bureau International d'Étalons Physico-chimiques) (Brussels, Belgium).—The Bureau of Physicochemical Standards was created in 1890 under the auspices of the International Union of Pure and Applied Chemistry. A close collaboration is now established between the University of Brussels and the bureau. Its transfer to its new quarters allows space for growth and free development. The bureau has its own laboratory, collections, and library, and may also use the scientific equipment of the university for the study of precision thermometry, calorimetry, refractometry, electrochemistry, high pressures, and so on.

This bureau prepares in a high degree of purity a variety of chemical substances for use in standardizing measuring instruments and determining fixed points on the scales of such instruments. Samples of these standard materials, together with certificates giving the values of their properties may be obtained from the bureau for certain fees.

The preparation in quantity of standards for low temperatures is nearly completed—toluene, isopentane, amyl oxide, ethyl acetate

(too unstable in air) on which further research is in progress. With samples of materials in use at the Bureau of Standards it is hoped to come into close agreement on the temperature scales so that when like collaboration is undertaken with the Physikalisch-Technische Reichsanstalt of Charlottenburg, the several countries will have a common basis for low temperatures down to −160°.

MISCELLANEOUS INTERNATIONAL ORGANIZATIONS

Several hundred international associations for the most varied purposes engage to a certain extent in standardization activities, For example, the International Union of Scientific Radio Telegraphy (president, Gen. G. Ferrie, France) has for its objects (1) to promote the scientific study of radio communication, (2) to aid and organize researches requiring cooperation on an international scale and to encourage the discussion and publication of the results, and (3) to facilitate agreement upon common methods of measurements and the standardization of measuring instruments. A Committee on Methods of Measurement and Standards (Dr. J. H. Dellinger. Bureau of Standards, Washington, D. C., chairman) determines standards with a particular view to the types of measurement work done by the other committees of this organization. It promotes and participates in the improvement and standardization of methods for measuring frequency, field intensity of received waves, intensity of atmospheric disturbances, automatic recording devices, fading, and other types of radio measurements. This organization illustrates a great variety of groups concerned to some extent with international standardization.

Another example is the Olympic Games Committee, which fixes the units, standards, dimensions, and measurements involved in every athletic event included in the four-year international athletic meet. The world records of achievements are established under definite rules of authenticity and accuracy.

Such organizations are too numerous even to list here, but their essential achievements in actual standardization work will probably be given adequate space in the next Yearbook.

PAN AMERICAN STANDARDIZATION CONFERENCES

At the instigation of delegates of several of the South American countries the Fifth International Conference of American States, meeting in Santiago, Chile, during April, 1923, authorized the calling of a Pan American Conference of experts to draw up agreements which could be used as inter-American conventions on points discussed. At the invitation of the Government of Peru, the First Pan American Standardization Conference was held at Lima during January, 1925.

At the Lima conference there was inaugurated a plan of organized standardization on an inter-American scale, the Inter-American High Commission being requested to draft an inter-American convention in which the signatory countries should (*a*) agree to provide for the continuous study and establishment of inter-American standards; (*b*) agree to establish organizations for this purpose; and (*c*) oblige such organizations to adopt certain general uniform principles and practices. This conference provided for the continuation of work by recommending that a second conference be convened and that the national sections of the Inter-American High Commission be charged with the continuity of work in the interim. A few specific projects received the indorsement of this conference and its recommendations that these matters be studied and acted upon by the participating countries.

The Inter-American High Commission, in conjunction with the Pan American Union, has decided that the second Pan American Standardization Conference shall be held in Washington, D. C., coincident with the Third Pan American Commercial Conference, which is to be convened during the first week in May, 1927. It is planned to secure the attendance at this standardization conference of leading business men of the Pan American countries, whose practical and expert knowledge of their products will enable them to discuss practical standardization proposals.

The Pan American Standardization Conferences are semiofficial, the powers of the national delegations being limited to recommendations that participating countries and the appropriate groups or trades within these countries adopt and enforce permissive and mandatory standards. They have been inaugurated to develop more uniform specifications and higher quality standards for commodities produced in the American countries, to promote greater production of relatively superior grades and qualities of materials, and to advance the standard of living.

III. NATIONAL STANDARDIZING AGENCIES

When weights and measures began to expand to include within their scope the various kinds of measurements other than length, mass, and capacity the movement for national institutions of a scientific nature resulted in the establishment of national bureaus equipped with laboratories and trained scientific experts for handling the scientific experimental procedure essential to research and testing in such fields as heat, light, electricity, sound, time, and the many other subjects. The example of the International Bureau of Weights and Measures (established in 1875) resulted in the establishment of the Physikalisch-Technische Reichsanstalt in Charlottenburg, Germany; the National Physical Laboratory, in Teddington, England; the Laboratoire d'Essais in Paris; the National Bureau of Standards in Washington. Standardization is a chief service rendered by these institutions. Supporting researches contribute to the accuracy of the standards and of methods of measurement. Inevitably the expert staff, scientific equipment and facilities, and experience attained in accurate measurements led each of these institutions in varying degrees to answer the appeal for service in connection with thier use in the industries. In other countries institutions on a smaller scale are rapidly taking up the broader functions.

Finally, the industries have taken up national standardization both through their technical societies and their standards committees, and through special national committees on standards on which are represented a wide range of interests, technical and industrial. (See Chapters VIII and IX.

NATIONAL BUREAU OF STANDARDS

[Washington, D. C.]

A detailed account of the organization and work of the National Bureau of Standards is given in Chapter VI of this Yearbook.

NATIONAL PHYSICAL LABORATORY

[Teddington, London]

The National Physical Laboratory is administered under a general board, of which Sir Ernest Rutherford is chairman, Sir Richard Glazebrook, chairman of the executive committee. It was established in 1899, at Teddington, as a general standardizing laboratory where standards and measuring instruments in use in science or trade may be verified and researches conducted of value to the public generally. The director of the laboratory is Sir J. E. Petavel.

The laboratory is divided into departments, comprising physics, electricity, metrology, engineering, aerodynamics, metallurgy, and metallurgical chemistry, and the national tank.

The results are published mainly in scientific and technical journals and in the proceedings of scientific and technical societies. For the year 1924–25 the publications numbered 105 official and 30 unofficial. See citation to annual report in the appendix under Bibliography.

MAINTENANCE OF STANDARDS

Primary Standards.—The laboratory is responsible for the primary and secondary standards of all kinds, British and international, which form the basis of measurement in Great Britain. "All working standards must be checked periodically against the primary standards, and the accuracy of the units of measurement ordinarily employed in the research and test of the laboratory must be maintained in relation to those of other countries."

Length.—A silica meter bar for India was made and verified. "Standard" invar tapes were graduated to better than 1 part in 8,000,000 of the total length. The oil film between two polished surfaces was found to be 0.0000005 centimeters thick. This was part of the preparations now in progress looking to the use of light waves as standards of length. Standard measuring instruments and methods have been improved. These include a new screw measuring apparatus, method of measuring the diameter of fine metal filaments.

Pressure, Mass, Volume.—The section handling barometers and manometers has aided the Air Ministry and the British Engineering Standards Association in the graduation of aircraft altimeter aneroids. Ninety-six standard weights were reverified, and the design of knife-edge balances studied. The kilogram-pound ratio as now determined is within 1 part in 50,000,000 of that certified by the International Bureau of Weights and Measures in 1889. Most scientific volumetric glassware is now graduated in terms of the milliliter as recommended by the Joint Committee for the Standardization of Scientific Glassware.

Government Research Under the Department of Scientific and Industrial Research.—Certain researches are being stabilized where long periods are required; for example, the properties of materials at high temperatures, minor metals, springs for motor vehicles, and an illumination research program. In the research on motor springs the laboratory collaborates with outside bodies. A new fatigue test machine has been built with automatic control for continuous 24-hour-a-day tests. Systematic data have been reported on typical spring steels, together with reports of their heat treatment. Experiments are in progress on the safe limits for repeated stress.

For the physics coordinating research board, work on color standards is in progress. An advanced stage has been reached in color measurement and standard methods of specifying color. A new instrument devised and constructed gives data for a complete specification of any color, from which any color may be reproduced. For the illumination research committee the effect of different kinds of illumination on the accuracy, speed, and comfort of workers has been investigated for the office of works. The minimum daylight for clerical work has been determined; studies of color and of diffusing materials have been made.

Temperature.—Research is in progress as a basis for proposals to be made to the International Commission on Weights and Measures in 1927 for a practical scale closely approximating the thermodynamic scale based on a number of fixed points.

Electricity.—Research disclosed that the electrical standard ohm differed by 1 part in 100,000 from previous values necessitating a redetermination ab initio with new tubes having more exact end faces.

The executive committee of the laboratory has been designated to consider a proposal to adopt absolute electrical units as defined in cgs units to replace the present international units (adopted 1908). Intercomparisons of some resistance standards with those of Germany showed the laboratory to be in agreement with the Reichsansalt within 1 or 2 parts in 100,000.

A standard of mutual inductance was constructed for Japan to replace the standard destroyed by the earthquake of 1922, and notable improvements based on mathematical investigation reduce the uncertainties in the dimensions of the secondary winding. Important improvements have been made in inductances for use at high frequencies.

A multivibrator wave meter, designed and constructed in the laboratory, has proved satisfactory as a primary standard of frequency. Quartz oscillators have been studied for reproducing selected frequencies with the precision of a primary standard.

Light.—Standards for mean spherical candlepower measurements have been compared with the standards of the National Bureau of Standards and of the Laboratoire Central d'Électricité, in pursuance of the recommendation of the International Commission on Illumination held at Geneva in 1924 that a black body operated under suitable conditions should be used as a primary standard of light. While at the temperature of the carbon lamp the agreement was good, high-efficiency lamps were less in agreement on account of the color differences.

Metallurgy.—Studies were made of the theory of lattice distortion in metals and its relation to other physical and mechanical proper-

ties. Experimental work has been done on the behavior of metals under plastic deformation at rates varying from slow compression to quick compression by explosives. In the iron alloys research pure iron has been produced free from oxygen. Special studies have been made of iron-chromium alloys up to 30 per cent of chromium. Highly pure chromium manganese and beryllium were also prepared. Silicon 99.7 per cent has been produced by chemical treatment of commercial silicon.

For the radio research board, received current strength has been measured under varied conditions. Radio and audio amplifiers have been studied, and a research on short waves continued. Waves of accurately determined frequencies have been broadcast, and the range of such frequencies will be extended.

For the food investigation board the thermophysical properties of certain refrigerating liquids were determined, methods devised for testing the strength of heat-insulating materials, and a calorimeter devised for measuring the heat evolved in the respiration process of fruit. The rate of penetration of heat or cold through masses of apples under sea-transport conditions was studied.

For the lubrication research committee investigations were made regarding sliding, rolling, and static friction under different conditions of lubrication and load. The pressure distribution on a hot cylindrical journal has been measured.

The laboratory prepared 106 official papers for publication, chiefly in the technical journals.

Divisional Researches.—The variety of research work in progress permits only a mere mention of typical items. The practical application of physics is illustrated by the experiments on heat transmission in cases of apples. The coefficient of diffusivity of heat into the mass of apples was determined by tests and mathematical analysis. A related item is the instrument for controlling the carbon-dioxide in the atmosphere of fruit stores. Application was made on the study of humidity, with equally practical uses, including the dimensional changes in leather at varying humidities, the permeability of building materials to water vapor.

In radiology the radium measurements, gamma ray protection, luminous compounds, X-ray protection, and absorption, and the radiographic examination of materials were items of special interest.

The work in sound included the photography of sound waves in a ripple tank on models duplicating the shape of the auditorium wall. The measurement of the absolute intensity of sound was made by newly-developed methods.

A multivibrator wave meter is serving satisfactorily as a primary standard. By the use of harmonics a wide range of frequencies may be standardized. A "spectrum of frequencies" was prepared.

The measurements of signal strength of received radio messages was continued on a wave length of 9,000 meters. The curve of intensity-distance distribution during daylight hours showed a clear maximum and minimum, and a simple shape, with the maximum at 400 kilometers, and minimum at 700.

An instrument for measuring daylight has been designed and constructed. This, with other equipment, is being used in a series of skylight measurements, which have been in progress for three or four years. A 10-foot integrating sphere photometer is now under construction.

In metrology, an important item was the comparison of 4-meter standard and the coefficient of expansion.

The rating of watches and chronometers has been continued, the laboratory procedure being reorganized. The winner of the highest marks in the grade A tests on watches was published. An increase in glass volumetric operators testing is noted, about 25 per cent compared with the preceding year.

In the program of building research, the study of wind pressures on structures has been continued with special reference to roof pressures and bridge pressures. In the work on aerodynamics a multitube dynamometer was designed and made for the simultaneous observation of the pressures at some 30 points on an air foil section.

Fundamental researches were conducted on the theory of fluid motion, and the fluid flow around air foils. The flow was photographed and typical photographs were published of the tests made for comparison purposes in the water channel. Experiments and studies were made of the spinning of airplanes, including numerous experiments on the capitol bantam airplanes, which shows unusual spinning characteristics. Other researches were made on wind flutters and the wind resistance of motor cars.

The metallurgical research on light alloys and the alloys of iron comprised a group of interesting problems, including a new apparatus for the electrodeposition of chromium. Of special interest was the investigation of alloys for use at high temperature. The laboratory was specially active in exploring the high temperature properties and possibilities of various alloys of a promising type. Studies of the fatigue of single crystals of aluminum and the deformation under reversed stress was examined by X-ray analysis.

PHYSIKALISCH-TECHNISCHE REICHSANSTALT

[National Physico-technical Institute, 25 Marchstrasse, Charlottenburg, Germany]

The Physikalisch-Technische Reichsanstalt functions under the Ministry of the Interior. It was established in 1887 at Charlottenburg as a national physical laboratory and standardizing bureau. Its purpose is the experimental advancement of exact physics and

of precision technology through scientific research and testing of measuring instruments and materials for all physical uses. In 1893 it absorbed the Reichsanstalt für Mass und Gewicht (National Weights and Measures Bureau). Its annual budget (1924) is nearly $238,000. Dr. Friedrich Paschen is president. Its divisions are (1) weights and measures, (2) electricity, (3) heat and pressure, and (4) optics.

1. Weights and Measures.—Subdivision 1a handles the administration of weights and measures, foreign weights and measures, and their verification and the work of certification, and bringing about international agreement. This subdivision is charged with making available the regulations of foreign testing laboratories.

Subdivision 1b is devoted to length measures, of which 18 classes, or an aggregate of 1,125, were tested in 1925. Of these, 521 were gauge blocks of highest precision. The expansion of a series of objects was determined, and 12 base-line standards for the geodetic survey of Russia were calibrated. The comparison of end-length standards by means of the krypton radiations 587 and 557 millimicrons wave length proved accurate to 1 part in 10,000,000, exceeding the accuracy of the definition of the prototype meter itself. Apparatus for comparing the krypton lines with the fundamental cadmium red, 643.8 millimicrons, is under construction.

A comparator has been constructed for intercomparing end standards up to 1 meter, and for intercomparing line and end standards, and wave-length determinations. With this it is now possible to establish the relation between line measurements and wave-length determinations with increased accuracy, and thus control the line prototypes.

The practice of using machines to measure lengths of fabric and areas of leather is coming into use in ordinary trade. This has led to requests for tests—a wire measuring and a fabric-measuring machine were tested by methods developed for the purpose.

Density.—Eighty-nine densimetric standards for Russia and Poland were tested with an accuracy of a few units in the fifth decimal place of the density determined. Investigation is under way to determine the concordance of the alcoholometer scales of Tralles, Stampfer, Mendeléef, and Osborne. Investigation was made of procedure for butyrometers and glass-measuring apparatus. Regulations reduce the error tolerance on large gas meters from 2 to 1 per cent. Testing of water meters and similar capacity meters shows increase.

2. Electricity.—Electrical Conductivity at Low Temperatures.—Measurements were made on the superconductivity of metals at the temperature of liquid helium to determine whether, as now seems probable, only one definite group of metals is superconducting, or whether with sufficiently pure materials or the use

of single crystals and sufficiently low temperatures all metals are superconducting. Of pure metals beside lead and tin, gold and zinc have been investigated with liquid helium and hydrogen and air. Conductivities of zinc and cadmium for heat and electricity were determined at 22.2, 89.7, and 273.2° absolute.

Electrical measures and apparatus in great variety were tested. For X-ray therapeutic dosage as well as pure physical research, equipment has been developed to be operated with 100 ma at 140 kv with the use of a Siegbahn vacuum spectrograph. Experiments have been in progress on the influence of chemical combination upon the Röntgen spectra of the elements.

The draft of new testing regulations was prepared for publication. The legal specifications for electric meters, now 25 years old, were believed to be inadequate to-day. An examination, however, showed that a change is not needed. The investigations were published in the Mitteilungen der Vereinigung der Elektrizitätswerke. During the London Röntgen Congress the German and British resistance units were compared by means of two 1-ohm and two 0.1-ohm boxes, showing a difference of 1 part in 100,000, the British unit being the larger. The change in electrical resistance proved to be feasible as a means of measuring the temperature of baseline wire standards, a tenth of a degree causing a resistance change of 2×10^{-4}, measurable with simple means.

Many standard frequency transmissions were made, the wave lengths of which were accurately established at the Reichsanstalt. Measurements of frequencies of piezo-electric oscillations in crystal quartz blocks showed a departure from true harmonic ratios because of the finite thickness of the block. The departure was found to be as high as 1 per cent at the twenty-first overtone. The velocity of sound in quartz which is involved was found to be 5,450 meters per second. Published accounts give detailed descriptions of the new glow-discharge resonators used as high-frequency standards based on the piezo-electric properties of quartz crystal. Here, when resonance takes place, the vacuum tube glows. Such luminous resonators serve as high-frequency standards for radio with an error less than 1 part in 10,000. Quartz block 80 millimeters long will give, besides its fundamental frequency of 34,100, also other harmonic difference frequencies.

Research was undertaken on the measurements of the velocity of light, the measurement of small capacities with double interrupter, on a synchronous motor for frequency measurement, on the cooling of standard resistances, the vibrations galvanometer for moderate frequency, the improvement of arrangements for measuring magnetism, effect of chemical combinations on thermal treatment, and on magnetizing of ferromagnetic alloys.

3. Heat and Pressure.—Isotherms.—The measurement of isotherms for neon and hydrogen in the equation of State investigations has been completed and published, so that observations are available between −183° C. and 400° C. up to 100 atmospheres for helium, hydrogen, neon, nitrogen, argon, and also within the limited range 0 to 200° for air and between 0.01 and 100° for oxygen. At the temperature of liquid hydrogen the isotherms of helium were measured.

Temperature Scale.—The Reichsanstalt has agreed to detailed proposals with respect to the international temperature scale as a basis for submission by the Bureau of Standards to the International Bureau of Weights and Measures. Measurements of black body temperatures for establishing the optical temperature scale are in progress; the melting point of platinum and the positive crater of the carbon arc are now determined. For measuring temperatures below the boiling point of oxygen, special facilities have been developed, including a helium-filled platinum resistance.

The melting point of hafnium, found by extrapolation from determinations on melts containing increasing proportions of hefnium oxide up to 93 in a HfO_2+XrO_2 mixture, indicating a melting point for pure hafnium 2,811° C. ± 25°. Other researches related to the measurement of the heat conductivity of insulating materials, ice, and certain metals, and the heat of vaporization of water under pressure, the liquefaction of hydrogen and helium, temperature coefficient of electrical resistance and of melting point, the total brightness of a black body, and so on.

4. Optics.—Fourteen series of measurements give 15.70 Hefner candles ±0.6 per cent as total brightness of the black body. Standard K and L wave lengths for the newly discovered elements (43 masurium and 75 rhenium) were measured and showed agreement in some cases better than 1 part in 1,000.

A number of high-precision flats were tested for planeness of surface and homogeneity. Work was done on a quartz monochromator, an ultra-violet mirror surface for collimating prisms, thermionic bolometer, fine structure of Kr and X spectral lines, and the many-line spectrum of oxygen.

Chemical Laboratory.—Chemical data were obtained on radioactive materials partly through difficult chemical operations. Samples of chemical glassware were examined with respect to alkali solubility and resistance as a basis for classifying them into hydrolytic classes.

Numerous photochemical researches were conducted, including a study of the concentration of elements 43 and 75 in the earth's crust found to be 10^{-12} or 10^{-13}. A prognosis of their properties led to

technique for examining the platinum ores and minerals of the earth acids. The X radiations $K\alpha1$, $K\alpha2$, and K1 were used, and their wave lengths compared as computed and as observed. A list of minerals in which indications were found was published.

In finer mechanics and acoustics the testing increased to 359 for the year, besides many measurements on quartz cylinders, spools, ohm tubes, wires, and the like. Tuning-fork comparisons by means of Lissajous figures first reached practical application in the problem of a Busoni third-tone voice harmonium which the Charlottenburg Hochschule fur Musik ordered of a piano manufacturing organization.

The list of publications in scientific and technical journals comprised 98 titles, including both the official papers and the personally prepared and privately published papers of the staff.

LABORATOIRE D'ESSAIS MÉCANIQUES, PHYSIQUES, CHIMIQUES, ET DE MACHINES

[Paris]

The Laboratoire d'Essais is under the Conservatoire National des Arts et Métiers and functions under the Ministry of Public Instruction and Fine Arts, Undersecretary of State for Technical Education. A technical commission of 23 members supervises the work. Its president is Émile Picard (permanent secretary of the Academy of Sciences).

Testing divisions comprise physics, metals, materials, machines, and chemistry.

The 3,148 tests (1924) were divided: 480 physics and measures, 1,331 metals, 551 materials, 121 machines, and 665 chemistry.

As reported by J. Loebuitz, member of the Technical Commission of the Laboratoire d'Essais: The laboratory has a budget of 1,082,762 francs (1924) exclusive of grant of Civil Engineers Society of France.

Total expenditures, 1,119,688 francs. Personnel has advanced from, 62 in 1913 to 119 in 1924.

The fees received for testing in 1913 equaled 51 per cent of the expenditures of the laboratory. By 1924 the percentage had changed to 96.

NATIONAL STANDARDIZING COMMITTEES

There are now national standardizing committees in Australia, Austria, Belgium, Canada, Czechoslovakia, Denmark, Finland, France, Germany, Great Britain, Holland, Hungary, Italy, Japan, Norway, Poland, Russia, Sweden, Switzerland, and the United States of America, making 20 in all. These have various relations with the governments of these countries.

Although there are considerable differences in their methods of functioning and in the authority bestowed on the standardizing com-

mittees in the several countries, fundamentally all of these committees operate similarly to the American Engineering Standards Committee, a description of which is given in Chapter VIII.

The national committees keep in active touch with each other, by correspondence, exchange of information on new projects, on drafts of standards, and on tendencies in national work in the respective countries. Another important arrangement is one by which each national standardizing committee acts as a sales agent for the approved standards of the other committees. Thus, through the American Engineering Standards Committee, copies of foreign specifications and standards are made readily available for American industries.

Three conferences of the secretaries of the national standardizing committee have been held—in London in 1921, in Zurich in 1923, and in New York in April, 1926.

IV. FUNDAMENTAL AND WORKING STANDARDS OF THE UNITED STATES OF AMERICA

[For illustration cited in this section see insert at end of volume]

The standards of measurement briefly described in this chapter are selected to give a fair idea of their design and workmanship, their variety, range of complexity, and the diversity of the measurements for which they provide. In general, elaborate comparators or special apparatus is required in using the standards. In several cases such equipment is shown, but in general only the standard is illustrated.

Many of the standards were designed and constructed at the Bureau of Standards. The construction of such standards is a primary legal function of the bureau. The bureau when established, in 1901, inherited only the standards of length, mass, and capacity. To-day it has standards, either primary or working, for almost every type of physical measurement. By no means all of these are herein described.

The custody of the standards and their maintenance involves continuous activity, sometimes actively controlled conditions. Standards of the volt are kept in stirred oil constant to within a hundredth of 1° C. For each other standard the conditions needed for preservation and constancy are determined by research and maintained in practice.

The standards of the Government are in all stages of development. Some are in the initial stage in new fields of measurement, others approach perfection. All represent scientific research through years of experiment and study in which were analyzed the nature of the things to be measured, the best means to gauge such magnitude, and the form and material best adapted to embody or reproduce such magnitude. These researches have been intensive and have called to their aid almost every branch of physical science and mathematical analysis. Such standards are the basis of the measurements of science and industry. To them all measured data refer ultimately, and upon them are, therefore, based specifications or standards of quality, performance, practice, or process, as well as those of dimension, hence all the measurements of industry and trade.

The classes of standards are given in the preceding outline of classification and purpose. Only the standards of measurement are illustrated in this book. The functions of the National Bureau of Standards of the United States Department of Commerce at Washington comprise with various degrees of completeness the development, construction, custody, and maintenance of reference and working standards and their intercomparison, improvement and application in science, engineering, industry, and commerce.

ACIDIMETRY

STANDARD FOR ACIDITY MEASUREMENT

[Pure benzoic acid, C_6H_5COOH]

Benzoic acid prepared synthetically is used as a standard of acidity. No impurity is detectable in the benzoic acid samples issued by this bureau. In using this sample a weighed portion is dissolved in alcohol and a few drops of a very sensitive indicator (phenolphthalein) are added. This indicator is colorless in acid solution, but turns pink in alkaline solution. A solution of sodium hydroxide is added from a measuring burette to the solution of benzoic acid. The solution turns permanently pink as soon as enough sodium hydroxide has been added to completely neutralize the benzoic acid. From the weight of the benzoic acid taken and the volume of sodium hydroxide solution used, the exact alkalinity of the sodium hydroxide solution can be computed. (See fig. 2.)

CALORIMETRY

STANDARD FOR HEAT OF COMBUSTION

[Pure naphthalene, $C_{10}H_8$]

The most convenient and accurate means for standardizing laboratory bomb calorimeters used to measure the heat of combustion of fuels, foods, etc., is by the use of standard materials of accurately known heat of combustion. In addition to naphthalene, which, as certified, has a heat of combustion of 9,622 (20°) calories or 40.25 kilowatt-seconds, per gram of material weighed in air against brass weights, there are furnished also sucrose, 3,949 calories or 16.52 kilowatt-seconds, and benzoic acid, 6,329 calories or 26.47 kilowatt-seconds, per gram.

Standardization by means of these substances consists in burning an accurately weighed amount of the substance in the bomb calorimeter under exactly the same conditions as when the bomb is used for heat of combustion measurements. This determines the rise of temperature of the calorimeter for the known amount of heat supplied and, since the temperature rise is proportional to the heat supplied, constitutes a standardization of the calorimeter.

If the rise of temperature employed in standardizing is nearly the same as that observed in ordinary use of the calorimeter the effects of minor errors are minimized.

COLORIMETRY

STANDARD OF COLOR

[Standard sunlight]

The primary standards of color of the Bureau of Standards are (*a*) frequency or wave length and (*b*) radiant flux. These two characteristics of radiation completely determine the objective color

CLASSES OF

STANDARDS

1

Standards of Measurement

Reference and working standards for measurements of all kinds, including fundamental and derived *standards of measurement* for expressing the quantitative aspects of space, time, matter, energy, and motion, and of their interrelations.

By definition, specification, or material standard, covering, for example, length, area, and volume; mass, weight, density, and pressure; heat, light, electricity, and radioactivity; including for each the quantity, flux, intensity, density, etc.

2

Standard Constants

Natural standards or the measured numerical data as to materials and energy, known as physical or *standard constants;* that is, the fixed points or quantities which underlie scientific research and industrial processes when scientifically organized.

Mechanical equivalent of heat, light, electricity, and gravitation; specific densities; viscosities; melting and boiling points; heat capacity; heats of combustion; velocity of propagation of light; conductivities of materials to heat and light; electrochemical and atomic weights; and many similar magnitudes determined experimentally with maximum precision and referred to fundamental standards of measure.

3

Standards of Quality

Specifications for material (by description, sample, or both), known as *standards of quality*, fixing in measurable terms a property or group of properties which determine the quality.

The numerical magnitude of each constituent property pertinent to the quality involved, and specific magnitude in units of measure of such significant factors as uniformity, composition, form, structure, and others.

4

Standards of Performance

Specification of operative efficiency or action for machines and devices, known as *standards of performance*, specifying the factors involved in terms susceptible of measurement.

Numerical statement of speed, uniformity, output, economy, durability, and other factors which together define the net efficiency of an appliance or machine.

5

Standards of Practice

Codes and regulations impartially analyzed and formulated after study and experiment into *standards of practice* for technical regulation of construction, installation, and operation, and based upon standards of measurement, quality, and performance.

Collation of standard data, numerical magnitudes, and ranges of the pertinent factors defining quality, safety, economy, convenience, and efficiency.

STANDARDS

PURPOSE

1

To *aid accuracy in industry* through uniform and correct measures;
To *assist commerce in size standardization* of containers and products;
To *promote justice in daily trade* through systematic inspection and regulation;
To *facilitate precision in science* and *technologic research* through calibration of units, measures, and instruments involved.

2

To *serve* as an *exact basis* for scientific study, experiment, computation, and design;
To *furnish* an *efficient control* for industrial processes in securing reproducible and uniformly high quality in output;
To *secure uniformity of practice* in graduating measuring instruments, or in compiling tables for standards of quality and performance, and wherever such uniformity is desirable; and
To *aid laboratory research by reducing errors* and uncertainty caused by use of data of doubtful accuracy.

3

To *secure high utility* in the *products* of industry by setting an attainable standard of quality;
To *furnish* a *scientific basis* for *fair dealing* to avoid disputes or settle differences;
To *promote truthful branding* and *advertising* by suitable standards and methods of test; and
To *promote precision* and *avoid waste* in science and industry by affording quality standards by which materials may be made, sold, and tested.

4

To *clarify the understanding* between maker, seller, buyer, and user as to operative efficiency of appliances and machines;
To *make exact knowledge the basis* of the buyer's choice; and
To *stimulate and measure mechanical progress.*

5

To *furnish* for each utility a single *impersonal standard* of practice as a *basis for agreement* of all interests, clearly defined in measurable terms;
To *insure effective design* and *installation* of utilities of all kinds;
To *promote safety, efficiency,* and *convenience* in the *maintenance* and *operation* of such utilities; and
To *secure uniformity of practice* where such is practicable, and *effective alternates* in other cases.

stimulus independently of the subjective color perceptive characteristics of the observer.

The standard instruments used in color measurements are calibrated in terms of wave length by reference to lamps which emit radiant energy of known wave length (for example, mercury, helium, etc.).

The working standards of spectral energy distribution are incandescent lamps (and filters). A working standard of sunlight developed and used at the bureau is the light from a gas-filled tungsten lamp (at 15.6 lumens per watt) modified by passing through a rotatory dispersion filter. The effect is that of a blue filter which by specific selective transmission so modifies the tungsten lamp radiation that it gives the observer's eye a spectral energy distribution closely similar to that of average natural noon sun at Washington.

The standard of reflection is magnesium oxide (MgO), prepared by combustion of magnesium turnings. Working standards of porcelain and other materials are used.

The working standards of selective transmission used are carefully polished glass plates. The fundamental standards of non-selective transmission are sector disks.

Working standards of color include colored cards and other colored materials.

COMPOSITION

STANDARDS FOR QUANTITATIVE ANALYSIS

[Example: Basic open-hearth 0.2 per cent carbon steel see fig. 5]

In 1905 the American Foundrymen's Association turned over to the bureau its standardized pig-iron samples, comprising four sets and covering a considerable range of compositions. The distribution of these was carried on after they had been reanalyzed by the bureau chemists and by some commercial testing laboratories.

The technical chemist when called upon to devise new and rapid methods to fit complex materials of a hitherto uninvestigated nature can not generally avail himself of the methods of the research chemist in handling but one or two variables at a time. The time at his disposal for investigation is necessarily limited, and research must be conducted along lines of greatest efficiency. The result has been the evolution of the standard analyzed sample. This may be defined as a material resembling as closely as possible the chemical and physical nature of the material with which the chemist expects to deal, and which has been analyzed by a sufficient number of methods and analysts to establish its average composition with considerable certainty. The use of such a sample is quite obvious where the chemist has at hand a material which when subjected to the usual

operation of analysis will behave like the stock material he expects to analyze.

Theoretically, there should be provided for the chemist at a works as many standard samples as he has different kinds of materials to deal with. Thus, in a steel works making steel by the Bessemer, basic open-hearth, or crucible processes, in addition to standards for all the raw materials there should be a standard sample for each different composition produced by the same process.

DENSIMETRY

WORKING STANDARDS OF DENSITY FOR LIQUIDS

[Hydrometers and picnometers]

Density is defined as the mass per unit volume. It may be expressed in grams per cubic centimeter, pounds per cubic foot, or in any convenient units.

The density of liquids is measured by the use of the picnometer, the hydrometer, and the hydrostatic weighing (plummet) method. The choice of method depends largely upon the nature of the liquid to be measured.

The hydrometer and the hydrostatic weighing method are much used in determining the density of transparent liquids of high fluidity, such as petroleum distillates, acids, and alcohols, while the picnometer is most often used for opaque liquids and liquids of high viscosity.

The standard hydrometers shown in Figure 6 are used by the bureau in checking similar apparatus and in determining the density of liquids.

ELECTRICITY

STANDARD OF ELECTRICAL CAPACITANCE

[The farad see fig. 7]

The unit of capacitance is the farad. The capacitance of a condenser is 1 farad when a change of 1 volt in the potential difference applied to its terminals will cause a change of 1 coulomb in the charge of the condenser.

In practice the capacitance of condensers is usually expressed in microfarads (millionths of a farad) or in micromicrofarads (trillionths of a farad).

The primary standard of capacitance of this bureau is a bank of 10 fixed air condensers, each having a value of 0.01 farad. Their value is determined in terms of the international electrical units by observing the average current that flows on to them when they are charged and discharged a known number of times per second with a known voltage. The secondary standards are mica condensers which are maintained continuously at a constant temperature of 25° C. The capacitance of these secondary standards is determined by comparison with the primary standards under definite conditions.

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The capacitance of condensers having certain geometric forms can be computed from the dimensions. Such computations are, however, based on electrostatic relations, and the results are, therefore, obtained in electrostatic units. To convert to micromicrofarads, the value in cgs electrostatic units is divided by 0.8988.

STANDARDS OF ELECTRIC CURRENT

[The ampere, see figs. 8 and 9]

The cgs electromagnetic unit of current is defined in terms of the magnetic field produced by the current. Several different but equivalent definitions are in common use. The following statement gives a physical picture of the effect of the magnetic field. A cgs electromagnetic unit of current flows in a circular circuit having a radius of 1 centimeter when the force on a unit magnetic pole placed at the center of the circle is 2π dynes. The ampere is one-tenth of the cgs unit.

On account of the difficulty (as it appeared at that time) of experimentally realizing the ampere from its definition, the London Electrical Conference of 1908 established the international ampere. It is defined as the "unvarying current which, when passed through a solution of silver nitrate in water * * * deposits silver at the rate of 0.00111800 of a gram per second." However, if a number of voltameters are in series, so that the same current passes through each, the deposit will be different in each voltameter. During the international experiments of 1910 differences of several parts in 10,000 in the weight of silver deposited were generally observed in each set of voltameter determinations. Therefore, the voltameter is not suitable as a laboratory standard for the measurement of current, but by taking the mean of 50 or 100 observations a value can be obtained which, together with a standard of resistance, will serve to fix the voltage of a group of standard cells. These cells are used as working standards with standard resistances to form a working standard for determining the unit of electric current.

Experimental work done at the Bureau of Standards shows that the ampere as derived from the cgs unit and the international ampere agree within the limit of experimental error. The cgs ampere can be determined with an accuracy of about 1 part in 100,000, while the uncertainty in the international ampere (partly on account of the lack of definite specifications for the silver voltameter) is several parts in 100,000.

From its nature, it is impossible to maintain a standard of electric current. However, a standard instrument for measuring current can be maintained. At the Bureau of Standards the Rosa-Dorsey current balance is the primary standard instrument for measuring

current. However, in laboratory measurements the current is generally determined by measuring the difference in potential which is produced at the terminals of a standard resistance.

STANDARDS OF ELECTROMOTIVE FORCE

[The volt, see fig. 10]

The cgs unit of electromotive force is that electromotive force which dissipates power in a circuit at the rate of 1 erg per second when a cgs unit of current is flowing. In respect to an electromagnetic circuit, an equivalent statement is that an electromagnetic unit of electromotive force is induced when the magnetic flux through the circuit changes at the rate of 1 maxwell per second. The volt is 100,000,000 times the cgs electromagnetic unit. On account of the difficulty of experimentally realizing the volt as thus defined, the international volt was established by the London Electrical Conference of 1908. This is defined as the potential difference between the terminals of a resistance the value of which is 1 international ohm, when the current which flows through it is 1 international ampere. In 1910 an international committee made experiments at the Bureau of Standards to determine, by means of the international ohm and ampere, the value to be assigned to the mean of a group of standard cells. Since that time the volt has been maintained by a group of standard cells. It is assumed that the mean of this group does not change.

The cells in the group which maintain the value of the volt at the Bureau of Standards are Weston normal cells. The positive electrode of these cells is mercury, the negative electrode a 12½ per cent cadmium amalgam, the electrode a saturated solution of cadmium sulphate with an excess of crystals, and the depolarizer a paste of mercurous sulphate. Such a cell must be kept for several days at a constant temperature before its electromotive force becomes stable. The Weston unsaturated cell is much less affected by temperature and is generally used as a secondary standard. Its construction differs from the Weston normal cell only in having an electrolyte which is saturated at 4° C., and hence is unsaturated at laboratory temperatures. Since the electromotive force varies slightly from cell to cell, for precision work must be determined for each cell by comparison with the standard group.

STANDARDS OF RADIO-FREQUENCY

[Wave length of radio waves]

The dimensions of radio-frequency are the reciprocal of time. Hence frequency is derivable from the unit of time, the second, and the fundamental standard upon which frequency standards are based is the standard of time, the rotating earth. In the practice of the Bureau of Standards the standard of frequency has been derived from time standards in a number of ways. Most of the methods involve

the measurement of a low frequency (a few hundred alternations per second) and a process of stepping up from this to radio-frequencies by the use of either a cathode-ray oscillograph or alternating-current harmonics. In one of the methods the low frequency used is measured by means of a pendulum, together with a chronograph. Another uses a combination of a tuning fork and oscillograph. Another uses an audio-frequency alternator and chronograph.

An independent method of establishing the standard of radio-frequency is the use of a radio-frequency alternator, together with a speed counter. Another is the calculation of frequency in terms of capacitance and inductance of a tuned circuit, these two quantities being determined fundamentally from speed measurements. An independent method in which direct use is made of the fundamental standard of length rather than that of time is the measurement of wave length of standing waves of very high frequency as produced on a pair of parallel wires, frequency being calculated from the observed wave length and the known velocity of light.

The standards used for maintaining the Bureau of Standards values of radio-frequency are three frequency meters and a group of piezo-electric quartz plates. The mechanical constants of the quartz plates are such that their frequencies of mechanical vibration are in the radio range of frequencies. By virtue of their piezo-electric property they introduce into radio circuits current variations of the same frequency as that of the mechanical vibrations. They are usable either as oscillators—that is, generators of current—or as resonators.

The working standards of frequency for the calibration of other instruments are a group of carefully constructed frequency meters. These instruments are combinations of capacity and inductance, together with an indicating device. One of the three primary standard frequency meters is shown in Figure 12.

STANDARDS OF ELECTRICAL INDUCTANCE

[The henry]

The unit of inductance is the henry, named after the distinguished American physicist, Joseph Henry, who made important investigations in the field of magnetic induction. The inductance between two circuits is, by definition, 1 henry if a volt is induced in one circuit whenever the current in the other changes at the rate of 1 ampere per second. Similarly, the self-inductance of a circuit is 1 henry if a counter electromotive force of 1 volt is induced when the current in this circuit changes at the rate of 1 ampere per second. A coil which has an inductance of 1 henry has an inductance of 1,000,000,000 cgs electromagnetic units.

The fundamental standard of self-inductance of this bureau is a single-layer coil wound on a porcelain form, which had previously

been ground to a true cylinder. This coil has an inductance of about 23 millihenrys. The inductance of such a coil not only can be measured in terms of the ohm and the second of time, but also can be computed from the mechanical dimensions of the coil and wire. The dimensions required are the diameter of the coil, the number of turns per centimeter, and the diameter of the wire.

STANDARDS OF MAGNETIC PERMEABILITY

[Typical standard magnetic test bars]

Carefully selected and prepared specimens of steel, the magnetic properties of which have been determined with high accuracy, are used as magnetic standards in the intercomparison and standardization of permeabilities; an accuracy of 1 per cent can be obtained. The bars of square section shown have been used in an intercomparison between the Bureau of Standards and the Laboratoire Central d'Électricité, of France. The standards must possess (*a*) magnetic uniformity along their length, (*b*) metallurgical stability, and (*c*) uniformity of section. (See fig. 13.)

In calibrating and using these magnetic standards mechanical strain or vibration must be avoided, as they affect the magnetic properties of the material, and care should be taken that standards are not heated during a test. The determination of the magnetic properties of steels entering into electrical machines and equipment is of the utmost importance both for economy of steel and the efficiency of design and operation.

STANDARDS OF ELECTRICAL RESISTANCE

[The ohm]

The cgs unit of resistance is the resistance of a circuit when a cgs unit of electromotive force causes 1 cgs unit of current to flow. The ohm is 1,000,000,000 cgs units. While the above definition requires only electrical measurements to determine the ohm, yet in practice it has been found convenient to construct apparatus which so involves the principles on which the fundamental units of current and electromotive force are based that a value of the ohm is obtained directly from measurements of length and time. Such measurements are difficult, and it is only recently that they have been carried out with precision.

The international ohm was established by the London Electrical Conference of 1908 as "the resistance offered to an unvarying electric current by a column of mercury at the temperature of melting ice, 14.4521 grams in mass, of a constant cross sectional area and of a length of 106.300 cm." The construction of such a standard is so difficult that a particular instrument may differ from the mean of a group by several parts in 100,000.

At the meeting of the international committee at the Bureau of Standards in 1910 it was agreed to take as the international ohm the mean of the values which had been obtained at the national laboratories of England and Germany. Since that time the international ohm has been maintained at the Bureau of Standards by a group of 1-ohm wire standards. Measurements made at the Bureau of Standards, 1912–1914, showed no measurable error in the adopted value of the ohm.

From measurements made in England and Germany, it is known that the international ohm is larger than the ohm as derived from the cgs units by about 1 part in 2,000. Hence, to obtain cgs ohms, multiply the value in international ohms by 1.0005.

FREQUENCY

WORKING LABORATORY STANDARDS

[Tuning-fork vibrations, see fig. 17]

The frequency of a tuning fork varies with temperature, amplitude, and the manner in which it is supported, and this is true whether the fork is running free or driven in some manner. For very precise work the fork must be calibrated in the position in which it is to be used and not disturbed in any way thereafter.

By means of a photoelectric cell operated by flashes from a free pendulum small-time intervals are obtained and recorded by a special oscillograph. When the vibrations of a tuning fork are rated against this standard, an accuracy of a few parts in 100,000 is readily obtainable.

The electromagnetic drive shown is one method of operating a fork and is generally sufficiently accurate for ordinary laboratory work.

[Pendulum oscillations, see fig. 16]

In order to secure an accurate sharply defined time scale as a permanent record, simultaneously recording any events which are to be measured with respect to time the apparatus shown in Figure 16 has been developed.

Light from the lamp, *L*, is interrupted by the swinging pendulum in *P* which allows a flash of the light to fall upon the photo-electric cell, *PC*, once every half second. The voltage change thus produced operates the amplifier, *A*, so that instantaneous current is obtained sufficiently large to operate the oscillograph, *O*. As the light from the oscillograph whips across the camera shutter a short horizontal line is recorded upon the camera film at every transit.

The film record on development appears as a series of thin transverse parallel lines.

GRAIN SIZE

WORKING STANDARD OF FINENESS

[Portland cement]

The degree of fineness of cement is an important factor in determining the quality of Portland cement. The Federal specifications require that the residue on a standard No. 200 sieve shall not exceed 22 per cent by weight. The bureau has prepared standard samples of this material to serve as a standard of fineness. The per cent of each sample of the cement passing through a standard No. 200 sieve is certified. (See fig. 18.)

The use of these standard fineness samples is a convenient way of maintaining control on standard No. 200 sieves to be used in cement testing. By comparison of the percentage of the sample passing through a sieve being tested and the per cent certified as passing through a standard sieve, the correction to the sieve may be obtained. This correction applied to the percentage passing the seive gives the true fineness of the cement. The standardization of sieves for conformity to the specification for dimensions of wires and openings is best accomplished by means of an optical projection apparatus.

METROLOGY (FUNDAMENTAL)

STANDARD OF LENGTH

[The meter, see fig. 19]

The primary standard of length in the United States is the national prototype meter No. 27, a platinum-iridium bar (90 per cent platinum and 10 per cent iridium), having a cross section which resembles the letter X and which is commonly called the Tresca section in honor of its originator. This shape was chosen because of its rigidity and low temperature lag and also because it permits placing the graduations in the plane of the neutral axis where the intervals so defined will not be sensibly altered by any flexure to which the bar might be subjected in use. The length of the bar, defined as the distance between a specified portion of two lines, has been determined by the International Bureau of Weights and Measures by comparison with the international prototype meter, and its length when at the temperature of melting ice certified by that bureau.

The Bureau of Standards possesses three secondary standards of length (of which the principal one is known as meter No. 21), these being platinum-iridium standards of the same cross section as the national prototype meter. They have all been certified by the International Bureau of Weights and Measures. Sets of precision gauge blocks serve as the secondary reference standards for contact measurement.

The secondary standard meter bars of platinum-iridium are sometimes used as working standards for work of very high precision. Other working standards at the Bureau of Standards are of an H-shape cross section and are made of nickel-steel alloys. Half-meter bars, decimeter bars, and various special graduated bars and scales are also used as standards for length measurements where line standards are required. For contact length measurements the working standards are precision gauge blocks, micrometer screws, etc.

In spectroscopy the wave length of red cadmium radiation is used as the standard. This wave length expressed as a decimal fraction of the meter was determined by Fabry, Perot, and Benoit in 1904. This value and that found by Michelson in 1892 are in agreement to 1 part in 15,000,000, using values reduced to specified standard conditions in each case.

The wave length of the principal radiation of helium is used as a working standard in the graduation of some precise scales, in the comparison of precision gauges, and in a number of other cases where the methods of interferometry are applicable.

STANDARD OF MASS

[The kilogram, see fig. 20]

The primary national standard of mass of the United States—the United States prototype kilogram No. 20—is a plain cylinder of platinum-iridium (90 per cent platinum and 10 per cent iridium) with diameter and height equal and slightly rounded edges. Its mass is certified in terms of prototype kilogram "K," the international standard of mass preserved by the International Bureau of Weights and Measures.

United States prototype kilogram No. 20 was constructed under the terms of the international treaty known as the Convention of the Meter, signed on May 20, 1875, by 17 nations, and approved by the President and the Senate. It was received by the President of the United States on January 2, 1890, and accepted on behalf of the Government. It is now kept on a polished plate of crystal quartz, under two concentric bell jars, in the standards vault of the Bureau of Standards in Washington, D. C.

This standard is 1 of 40 such "prototypes" made and tested at the same time. One of the lot was selected to be the international standard, and others were then distributed by lot to the various governments in the international organization. In addition to No. 20 the United States received also kilogram No. 4, which now constitutes the best of the secondary standards, being practically on a par with kilogram No. 20 except in the matter of formal recognition.

These new standards were so much better than any other standards available at that time that in 1893 the Office of Standard Weights and

Measures decided that "greater stability in weights and measures, as well as much higher accuracy in their comparison" could be obtained by deriving from the new standards not only the other metric units, such as the gram and milligram, but also the various avoirdupois, troy, and apothecaries' units. Ever since that time the following equivalents have been used in defining the relations between metric, avoirdupois, troy, and apothecaries' units.

1 pound troy or 12 apothecaries' ounces = 5,760 grains.
1 avoirdupois pound = 7,000 grains.
1 avoirdupois pound = 0.4535924277 kilogram.

The relation adopted between the avoirdupois pound and the kilogram is the value determined as the result of the joint work in 1883 by the British Standards Office and the International Bureau of Weights and Measures.[1]

Among the more important secondary standards are a set from 500 grams to 1 milligram made of the same material as the national prototypes, four standards of 1 avoirdupois pound each, of heavily gold-plated tobin bronze, together with one standard of 10 troy ounces and two of 1 troy pound, also of gold-plated bronze. These and certain other secondary standards are occasionally used for extremely accurate work, while still others derived from these, are used as ordinary "working standards" for most of the work.

The working standards range from 0.05 milligram (about $\frac{1}{10000000}$ pound), used in testing small weights for laboratory work, up to test cars of 80,000 pounds, used in testing railroad track scales.

The value of national prototype No. 20 is known in terms of the international kilogram to an accuracy of about 1 or 2 parts in 100,000,000. The best standards can be compared with each other with a precision a little beyond this, but there are few standards that will not change their values by more than 1 part in 100,000,000 even when not used.

The precision of mass determinations is at present limited by minute uncertainties in calculating air density, which must be done to make correction for air bouyancy, and by uncertainty as to variations in the air and water vapor film that adheres to the surface of the weight.

VOLUME

STANDARD OF VOLUME

[Liter and other units of capacity]

The liter is a unit of capacity equivalent to the volume occupied by a quantity of pure water having a mass of 1 kilogram at the temperature of its maximum density and under standard atmospheric pressure (760 mm). The milliliter (ml), the one-thousandth

[1] Board of Trade (England) Report for 1884. Travaux et Mèmoires (International Bureau) **2**; 1885.

part of the liter, is employed as the unit of volume in practically all volumetric apparatus and analyses. The cubic centimeter (cm^3), which is smaller than the milliliter by 27 parts in 1,000,000, is used as the unit in measurement of volume derived from length measurement.

The gallon is a unit of capacity equivalent to a volume of 231 cubic inches.

Volumetric glassware is tested by determining the weight and temperature of the water contained or delivered by the interval under test, the volume being calculated by the use of water-density tables. Convenient tables for this purpose are given in Bureau of Standards Circular No. 19, "Standard Density and Volumetric Tables." For certain types of apparatus, such as flasks and cylindrical graduates, standards of volume are used, these having been calibrated by the weight method.

See Figure 21 for illustrations of various sizes of working standards as used by the bureau.

STANDARD OF TIME

[Precision clock]

The standard for the measurement of time is derived from the motion of the earth on its axis and in its orbit around the sun. The solar day is the time of one complete rotation of the earth on its axis, and the solar year is the time of one complete revolution of the earth in its orbit around the sun.

In its annual journey around the sun the earth is at varying distances from the sun and is moving at varying speeds in its orbit. As a result of these differences the length of the solar day—that is, the time between two successive apparent passages of the sun through the earth's meridian—is different at different seasons of the year. It would be exceedingly difficult to construct and to regulate a timekeeping device so that it would indicate actual solar time. In order to avoid this difficulty a "mean solar day" has been defined in terms of the motion of a fictitious sun, which is sometimes ahead of and sometimes behind the actual sun in its apparent daily rotation around the earth. Our ordinary timepieces are regulated to keep time with this "mean sun"; that is, to keep mean solar time.

There is another kind of time, known as sidereal time or star time, which is derived from the apparent motion of the fixed stars in relation to the earth. This differs by about four minutes a day from solar time and is used principally in astronomy.

The standard of time measurement for the Bureau of Standards is the high-precision Riefler clock (fig. 22), which is capable of keeping correct time to within 0.02 second a day. This clock is

provided with an invar pendulum which swings in a partial vacuum. Means are also provided for changing the pressure within the air-tight glass chamber which incloses the entire clock, thus regulating the rate of swing of the pendulum. The second signals from the clock are conducted electrically to the testing laboratory, where they are recorded automatically.

Precision time measurements in research may be made to within 0.001 second, and intervals of time to the order of a millionths of a second have been measured. The bureau Riefler clock time is compared daily with noon signals from the Naval Observatory as received by radio through the Arlington radio station. These signals are recorded automatically on the sheet of a drum chronograph, together with the signals from the Riefler clock, as notches in a continuous pen-traced line. The speed of the drum is so regulated that the pen travels 2 centimeters a second, and the time of the two signals may be easily compared to 0.01 second by means of a scale (fig. 23). Thus time is reduced to a traced line upon which notches represent definite time observations.

Washington time is based upon the international time zone system, in which the meridian passing through the observatory at Greenwich, England, is taken as zero. This system has been used in the United States since 1884, but it was not until March 19, 1918, that Congress assigned its regulation to the jurisdiction of the Interstate Commerce Commission. Under this system Washington time is that of the seventy-fifth meridian west, which is five hours slower than Greenwich time, since 15° of longitude makes a difference of one hour in time.

OXIDIMETRY

OXIDIMETRIC STANDARD

[Pure sodium oxalate $Na_2C_2O_4$, see fig. 24]

Sodium oxalate of certified purity is used as a standard of reducing power. It serves as a means to determine the oxidizing power of potassium permanganate, which can then be used with accuracy. A weighed portion of sodium oxalate is dissolved in dilute acid, and a solution of potassium permanganate is added from a measuring burette. The sodium oxalate reacts with the colored potassium permanganate solution and decolorizes it. The solution does not become permanently pink until enough permanganate has been added to completely destroy the sodium oxalate. The oxidizing power of the solution of potassium permanganate can then be computed from the weight of sodium oxalate taken and the volume of potassium permanganate required.

The nature and purity of primary standards are fundamental to the accuracy of any volumetric process. This bureau aims to remove

the discrepancies which arise from the use of unsuitable or impure standards in chemical analysis. It was for this purpose that this primary standard in volumetric analysis was added to our list of standard analyzed samples.

PHOTOMETRY

STANDARDS OF LUMINOUS INTENSITY

[The international candle, see fig. 26]

The primary standards of luminous intensity, on which all measurements of light are ultimately based, are groups of electric incandescent lamps maintained in several national standardizing laboratories. Since 1909 the national laboratories of France, Great Britain, and the United States have maintained a common unit of candlepower by means of such groups of lamps. The unit is commonly called the international candle, but it is also known as the British candle and the bougie decimale. A satisfactory reproducible primary standard of luminous intensity has not yet been produced. When a reproducible primary standard is found, the value assigned to the unit will, no doubt, be the same as the mean value of the present existing groups of incandescent lamps.

The group of lamps which constitutes the basic reference standards in terms of which the unit of candlepower is maintained at the Bureau of Standards consists of 45 carbon filament 4-watts-per-candle electric incandescent lamps, divided into seven subgroups. Two of these subgroups have been intercompared with similar groups at the national standardizing laboratories of England, France, and Germany. The Hefner candle, which is the unit employed in Germany and some other European countries, is 0.9 of the international candle.

Intercomparisons of the groups of lamps can be made to within an accuracy of approximately 0.2 per cent, and such intercomparisons made at intervals of several years show that the basic reference standards are maintaining their assigned values within the experimental errors of the measurements.

Secondary reference standards and working standards in the form of vacuum-tungsten lamps and gas-filled tungsten lamps have been established by different procedures in the several national laboratories, and it appears that there may be differences as large as 3 to 4 per cent between the values assigned in different countries. These deviations are the result of the unavoidable color differences between carbon-filament lamps and tungsten-filament lamps.

Flame standards of luminous intensity are now rarely used, but the national laboratories are prepared to test and certify Hefner lamps and Vernon Harcourt pentane lamps. The candlepower of

these lamps varies with atmospheric conditions of humidity, pressure, and carbon dioxide content. An accuracy of 1 per cent is the best that can be obtained in the certification of flame standards. The color of the light of flame standards is much redder than that of tungsten lamps, which is a further disadvantage in their use.

PLANOMETRY

STANDARD OF PLANENESS

[Quartz flats]

The standard of flatness or planeness is a set of three quartz circular flat surfaces which tested in contact in any orientations or combinations do not show appreciable or measurable deviations from flatness.

The three disks of clear fused quartz about 10 inches in diameter are 1½ to 2 inches thick, and their surfaces depart less than one one-hundredth of a light wave length from plane. These standards are self-checking, requiring no units of measurement for their verification.

Such standards are of practical importance in the testing of planeness of surfaces, the straightness of edges, and the limiting surfaces of end gauges, and also for producing standard angles and for calibrating instruments used to measure curvature of surfaces.

Upon these uses of the standard of planeness depend many important modern developments of scientific technique and its industrial applications.

POLARIMETRY

STANDARD FOR OPTICAL ROTATION

[Pure sucrose, $C_{12}H_{22}O_{11}$, see fig. 25]

The sucrose content of a sample is determined by means of the saccharimeter. This universally used instrument is standardized by means of pure sucrose. The International Sugar Commission define the normal sucrose solution which should read 100 on the scale of the instrument. As the rotation of the normal solution of sucrose is known in circular degrees, it is also possible for each user of a saccharimeter to standardize his instrument daily by means of a quartz-control plate whose rotation is accurately known. It is therefore necessary to prepare sucrose of the highest purity for use in determining two fundamental "international" physical constants. The first is the physical constant 100 point on the saccharimeter scale, known as the 100-degree sugar point, and the second is the rotation in circular degrees of the solution for a known monochromatic source of light. By means of the former constant, quartz-control plates can be rated in terms of sugar degrees. Exhaustive studies of the factors determining the values of these constants were made by the bureau and previous values found to be in error by more than one-tenth of 1 per cent (a relatively large error). At 20° C. the normal sucrose

solution rotates light having a wave length of 546.1 millimicrons through an angle of 40.763°, and a wave length of 589.25 millimicrons through an angle of 34.616°.

The recognized purity of the bureau's sucrose makes it a standard for calibrating the calorimeters used in measuring the heat of combustion of foods and fuels, as well as for the determination of the specific rotations of sucrose and for other scientific uses. The heat of combustion is 3,949 calories per gram and the specific rotation for light of wave length 546.1 millimicrons is 78.342° and for 589.25 millimicrons 66.529°. The values of these constants are stamped on each label.

STANDARD REDUCING SUBSTANCE

[Dextrose, $C_6H_{12}O_6$]

One of the most important and most generally used methods in sugar analysis is the determination of the so-called reducing sugars. This class of sugars has the power of reducing copper in alkaline solutions, the amount reduced being a measure of the amount of these sugars present in a given sample. One of the sugars in this group, namely, dextrose, is arbitrarily chosen to serve as the standard reducing substance and its reducing power taken as 1.

Dextrose of high purity is issued as one of the standard samples of the bureau with a view to assisting in the standardization of analytical determinations of reducing sugars. In the preparation of this material the purest dextrose or "corn sugar" of commerce is dissolved by heating in 40 per cent of its weight of water, treated with one of the decolorizing carbons, and filtered. The filtered solution, which is water white, is placed in a crystallizer of the rotating type and allowed to crystallize in motion. After crystallization is complete the crystal mass is centrifuged and washed several times with redistilled alcohol. The crystals are very white and already possess a high purity. They are then dissolved in water, filtered, and recrystallized. The second crystals are carefully dried and the polarization, ash, and reducing power determined. If these tests indicate the presence of any remaining impurities, the recrystallization is repeated until a satisfactory product is obtained.

The amount of reduced copper obtained in either a volumetric or gravimetric determination of reducing sugar is dependent in great measure upon the conditions of the particular analysis carried out. Errors may arise from impurities in reagents, time of boiling, or from many other circumstances connected with individual differences of procedure. These errors, however, are eliminated if the analyst standardizes his own procedure by means of a known quantity of reducing substance, such as pure dextrose, and subsequently adheres rigidly to the same procedure. The standard dextrose solution may be prepared very readily and conveniently

by weighing out the required amount of solid substance and dissolving in the necessary volume of water. In this way a neutral solution of known composition is very rapidly prepared.

PYROMETRY

STANDARDS FOR TEMPERATURE FIXED POINTS

[Freezing points]

Secondary Thermometric Fixed Points.—The freezing points of certain metals provide a convenient means of reproducing thermometric fixed points. When the freezing point of a lot of metal has been determined on the standard temperature scale, samples from this lot provide a means for checking the reading of any temperature-measuring device at this point. The choice of metals for this purpose is governed by such considerations as availability, convenience in use, and freezing point. Some metals which have been found suitable are shown above. These metals and their freezing points are, tin, 231.9°; lead, 327.4°; zinc, 419.45°; aluminum, 658.7°; and copper, 1,083° C. (See fig. 29.)

RADIOLOGY

STANDARD OF RADIOACTIVITY

[Radium chloride, $RaCl_2$, see fig. 30]

The primary international standard of radium is the international radium standard preserved in the Bureau International des Poids et Mesures (International Bureau of Weights and Measures) at Sèvres, near Paris, France. This standard, prepared by Madame Curie, is 21.99 milligrams of pure radium chloride ($RaCl_2$) in a hermetically sealed thin glass tube.

The primary national standard of radium of the National Bureau of Standards is known as "secondary radium standard No. 6." It is similar to the international radium standard. It was compared directly with the international standard under the auspices of the Commission Internationale des Étalons de Radium and certified (in 1913) to contain 20.68 milligrams of radium chloride ($RaCl_2$) as measured by its gamma radiation. This is contained in a tube of Thüringen glass 0.27 millimeter wall thickness. This stated mass of $RaCl_2$ corresponded to an actual mass of contained radium equal to 15.44 milligrams, taking the atomic weight of radium as 226 and that of chlorine 35.457 (referred to oxygen as 16). All measurements and certifications by the Bureau of Standards are based on this value as the true mass of the element radium present in October, 1913. The radioactive transformation of radium causes the standard to lose radioactivity at a rate of about 1 per cent in 25 years, so that the standard at present (computed Aug. 1, 1926) is equivalent to 15.360 milligrams of radium.

The more important secondary working radium standards, four in number, have masses, respectively, of 4.144 mg (Feb. 5, 1926), 9.89 mg (Aug. 29, 1926), 24.74 mg (Oct. 19, 1926), and 49.52 mg (Oct. 20, 1926).

In the actual use of these standards, the observer measures the effect of the standard in discharging (by ionization) the electric charge upon the gold leaf of an electroscope by comparing the rate of fall of the leaf caused by the standard with that caused by the preparation to be tested.

The buying and selling of radium products in the United States are based upon the bureau's measurement of the gamma ray activity of the specimens offered for sale and the certificates giving their radium equivalent.

Conditions affecting the accuracy of determination are taken into account, including the natural ionization of the atmosphere. The resulting accuracy is within 1 part in 100. The precision of the certified comparison by the Commission International de Radium was within 1 part in 500.

RADIOMETRY

STANDARD OF TOTAL RADIATION

[Radiant energy, see fig. 31]

The standard of radiation is the total radiant energy emitted by a seasoned certified carbon-filament incandescent electric lamp. It differs from a standard of light which defines candlepower, in that the standard of radiation gives the total energy flux, of the invisible as well as the visible radiation. A typical value for the radiant energy of one of these radiation standards, is equal to 114.4×10^{-8} watts at 0.400 ampere and 125.0 volts.

SACCHARIMETRY

STANDARD FOR OPTICAL ROTATION

[Quartz-control plates]

Figure 32 shows the Bates adjustable sensibility polariscope, a modern high-precision saccharimeter, and several of the standard quartz-control plates used in connection with it for making accurate measurements of the per cent of sugar contained in the samples to be analyzed.

The quartz-control plates, the working standards for optical rotation, are disks of quartz about 15 mm in diameter and 1.593 mm (or less) thick, according to the point on the saccharimeter scale which they are designed to check. They must be cut from optically homogeneous quartz, and the faces, which must be optically plane and parallel to about a quarter of a wave length of light, must be accurately at right angles to the optical axis of the quartz crystal.

They are mounted in the heads of the tubes shown in a group beside the saccharimeter, in such a way as to be held accurately at right angles to the axis of the tube. They must be free from all mechanical strain. They are carried in a long tube so that they will be held in the instrument accurately at right angles to the path of the light. The 100.00° plate corresponds to a circular rotation of 40.690° for mercury green light of $\lambda = 5461$ Ångstrom. The particular plates shown are the working standards used at the Bureau of Standards for calibrating saccharimeter scales.

The quartz plates have the same effect upon a beam of polarized light as does a sugar solution. These plates when properly prepared and standardized are permanent, there being no change in the optical rotation or sugar value of the plate over the period of many years. These plates, therefore, are used to check up and correct for any small accidental variations in the saccharimeter, a reading of one or more plates being made during each set of sugar tests and the approximate correction applied to all readings made under the same conditions, if the reading of the plate differs from its true value previously determined at the Bureau of Standards.

The order of accuracy required in sugar work must be the very highest obtainable as may be judged from the fact that an error of one-tenth of 1 per cent in the determination of raw sugars imported would correspond to a difference of about $200,000 annually in the amount of duty collected.

SPECTROSCOPY

STANDARD FOR WAVE-LENGTH MEASUREMENTS

[Ångstrom, see figs. 33 and 34]

The primary standard of wave length of light is the red radiation of cadmium. The wave length of this radiation of cadmium = 6438.4996 Ångstroms (1 Ångstrom = 1Å − one ten-millionth of 1 millimeter) and this equivalent was formally adopted in 1907 by the International Union for Cooperation in Solar Research, now known as the International Astronomical Union, the office of which is at Gonville, Cais College, Cambridge, England.

The standard equivalent may be used either to derive the length of 1 Ångstrom a unit of length, or to express the value of other lengths in terms of the Ångstrom. The equivalent is that determined by Fabry, Benoit, and Perot, in 1904, using interferometric methods at the International Bureau of Weights and Measures, to determine the number of light waves in the prototype meter. The equivalent is believed determinable to 1 part in 15,000,000 or better.

Secondary standards, wave lengths of iron and neon radiations, have been determined relative to the cadmium red radiation, and adopted as secondary standards by the International Astronomical

Union. These wave lengths have been measured at the Bureau of Standards. The neon wave lengths were determinable and reproducible to 1 part in 10,000,000.

The standard "frequency" is used in the study of atomic energy levels. The absolute "frequency" is the velocity of light (in cm per second) divided by the wave length (in centimeters). This is not known better than 1:5,000. (Michelson in pending determination of the velocity of light expects to increase the accuracy to 1:30,000.) The "wave number" (number of waves per centimeter in vacuum) is known to better than 1 part in 1,000,000 for most spectral lines, and is therefore more suitable for use in connection with atomic radiation.

THERMOMETRY

STANDARD TEMPERATURE SCALE

The ideal basis for temperature measurements in scientific and technical work is the thermodynamic scale, which is based on the laws of thermodynamics and is independent of the properties of any particular substance. A standard scale is maintained for practical use. This standard scale is as close an approximation to the thermodynamic scale as is possible with present knowledge, while at the same time it has the desirable qualities of high precision, simplicity, and convenience, and can be independently reproduced in any suitably equipped laboratory. (See fig. 35.)

The standard scale is defined by a series of thermometric fixed points, namely, the boiling point of oxygen, −183.00°, the melting point of ice, 0°, the boiling point of water, 100° C., the boiling point of sulphur, 444.6°, the freezing point of silver, 960.5°, and the freezing point of gold, 1,063° C. Interpolation between the fixed points and extension above the gold point are accomplished by means of specified instruments and equations. The platinum resistance thermometer with one interpolation equation is used in the range 0 to 650° C., and with a second equation in the range 0 to −193° C. The standard platinum versus platinum-rhodium thermocouple is used for interpolation between 650 and 1,063° C. Extension of the scale above 1,063° is based on Planck's law for the spectral distribution, and variation with temperature, of the energy emitted by a uniformly heated inclosure or black body. The instrument used to determine temperatures in accordance with this law is the disappearing-filament optical pyrometer.

V. FEDERAL STANDARDIZING AGENCIES

(Executive Departments)

DEPARTMENT OF AGRICULTURE

The Department of Agriculture is represented on the executive committee of the Federal Specifications Board by the chief, division of purchases, sales, and traffic.

In addition to the representation on technical committees of the Federal Specifications Board, from bureaus separately mentioned, members of various other department activities serve on 14 technical committees, as department representatives.

BUREAU OF AGRICULTURAL ECONOMICS

Members of the bureau represent the Department of Agriculture on seven technical committees of the Federal Specifications Board.

Standard grades for various commodities have been developed and promulgated under the provisions of various laws as follows:

Cotton.—The first Federal grades were promulgated under the provisions of the cotton futures act of 1914. The application of these standards was extended by the cotton standards act, 1924, to require the use of the United States grades for cotton in all transactions based upon grade.

Grain.—The grain grades have been promulgated under the provisions of the grain standards act of 1916.

Wool and Tobacco.—The United States warehouse act of 1916 gave the Department of Agriculture the authority to promulgate grades for the compulsory use of licensed warehousemen in connection with the issuance of warehouse receipts where the receipts state the grade. The only grades which have been officially promulgated under this act are the wool grades, but an extensive study of tobacco grading has also been conducted and tentative grades have been formulated.

Other Commodities.—The authority for all other Federal grades recommended by the Department of Agriculture is found in the Agricultural appropriations act. The following is a check list giving the commodities for which standards have been promulgated, together with the date of issuance and also the dates of revision:

Check List of Standards for Farm Products Formulated by the Bureau of Agricultural Economics (Revised to October, 1926)

A "mandatory standard" may be defined as an official standard, the use of which is compulsory in the conditions specified by the law under which that standard is promulgated; for instance, the

"official grain standards of the United States" for wheat are compulsory for grain shipped by grade in interstate commerce, according to the United States grain standards act.

A "permissive standard," as here used, may be defined as a standard which has been worked out and recommended officially for optional use. Such permissive standards are used by the United States Department of Agriculture in such lines of work as inspection and market news. Permissive standards are often adopted by States as mandatory under certain conditions.

A "tentative standard," as here used, may be defined as a standard that is still subject to investigation by the Department of Agriculture, that is offered for use under commercial conditions to test its practicability or as a basis for discussion. Such a tentative standard may later become either a permissive or a mandatory standard, according to circumstances.

Manatory Standards.

(*Under United States cotton futures act and United States cotton standards act*)

COTTON:

American upland—

White grades: Promulgated 1914; revised 1923; partially revised 1924.

Yellow tinged, yellow stained, and blue stained colors: Promulgated 1916; revised 1923.

Gray, spotted, and light stained: Promulgated 1922.

Extra white: Promulgated 1926; effective 1927.

American Egyptian (grade and color).—Promulgated 1918; revised 1923; discontinued 1925, when the 1918 standards were reestablished.

Sea Island (grade and color).—Promulgated 1918; discontinued 1925.

Length of staple.—Promulgated 1918; original representations revised 1925.

NOTE.—S. R. A. 92 (Agr. Econ.) contains description of all cotton standards now in force.

American cotton linters.—Promulgated 1925; Effective 1926. (See S. R. A., 94 (Agr. Econ.).)

(*Under United States grain standards act*)

GRAIN:

Shelled corn.—Promulgated 1916; revised 1918; amended 1921, 1924.

Wheat.—Promulgated 1917; revised 1918; amended 1921, 1922, 1924.

Oats.—Promulgated 1919; amended 1924, 1925.

Rye.—Promulgated 1923; amended 1924.

(Handbook U. S. G. S. A. 90 contains descriptions of these standards.)

Grain sorghums.—Promulgated 1924.

Feed oats.—Promulgated 1925.

Mixed feed oats.—Promulgated 1925.

(Handbook U. S. G. S. A. 161 contains descriptions of these standards.)

Barley.—Promulgated 1926. (See Handbook U. S. G. S. A. 165.)

(*Under United States standard container act*)

CONTAINERS:

Climax baskets.—Promulgated 1916.

Berry boxes.—Promulgated 1916.

Till baskets.—Promulgated 1916.

(See Office of Secretary Circular 76.)

(*Under United States warehouse act*)

WOOL:

Diameter of fiber.—Promulgated 1923; Revised 1926.[1] (See S. R. A. 100 (Agr. Econ.).)

NOTE.—Licensed tobacco warehousemen are required to use tobacco grades which have been devised for the purpose, and licensed sirup warehousemen are required to use standards promulgated by the Bureau of Chemistry for maple and cane sirup. (Office of Secretary Circular 136.) When storing any commodity for which United States grades have been officially promulgated, such grades must be used if the warehouse receipt states the grade. In the absence of official grades the department approves such grades for use by licensed warehouse men as seem best to meet the needs.

Permissive Standards:

(*Under United States grain standards; used as a basis for trading but not officially promulgated and not under Government inspection*)

RICE, MILLED.—Recommended 1918; revised 1923. (See Dept. Cir. 291.)

RICE, ROUGH.—Recommended 1923. (See Dept. Cir. 290.)

(*Used in services offered under annual appropriation acts covering inspection of fruits, vegetables, hay, and other perishable farm products (shipping point and market inspection); used in extension and demonstration work*)

BEANS, DRY EDIBLE (19 classes).—Recommended 1926. (Mimeographed circular.)

BROOM CORN.—Recommended 1926. (Mimeographed circular.)

BUTTER.—Recommended 1918. (See S. R. A. 51 (Markets).)

CHEESE, AMERICAN (WHOLE MILK).—Recommended 1922. (See Office of Secretary Circular 157.)

FRUITS AND VEGETABLES:

Apples, barreled.—Recommended 1918; revised 1924, 1926. (See S. R. A. 93 (Agr. Econ.) Amend. 1.)

Artichokes.—Recommended 1926.

Asparagus.—Recommended 1922; revised 1925.

Beans, string (wax or green).—Recommended 1924.

Beets, bunched.—Recommended 1924.

Cabbage.—Recommended 1922; revised 1924.

Cantaloupes.—Recommended 1924; revised 1926.

Carrots, bunched.—Recommended 1924; revised 1925.

Cauliflower.—Recommended 1922; revised 1925.

Celery.—Recommended 1922; revised 1925.

Cherries, sweet.—Recommended 1926.

Citrus fruits.—Recommended 1923; revised 1924.

Corn, green.—Recommended 1926.

Cucumbers.—Recommended 1922.

Dewberries and blackberries.—Recommended 1926.

Eggplant.—Recommended 1925.

Grapes, American, eastern type bunch.—Recommended 1925; revised 1926.

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[1] In 1926, the former 7 grades were expanded to 12, and a numerical system of designation substituted for the grade names formerly used. The new United States grades have been correlated with the English count system of grading. Standards for 12 grades of wool top were also promulgated in 1926.

Permissive Standards—Continued.

Fruits and Vegetables—Continued.

Grapes, table.—Recommended 1924; revised 1926.

Grapes, juice.—Recommended 1923; revised 1926.

Grapes, packed in sawdust or other packing material.—Recommended 1925; revised 1926.

Lettuce.—Recommended 1923; revised 1926.

Onions, Bermuda.—Recommended 1918; revised 1925.

Onions, Creole.—Recommended 1926.

Onions, northern grown.—Recommended 1920; revised 1925.

Peaches.—Recommended 1922; revised 1924.

Peanuts, farmers' stock white Spanish.—Recommended 1924; revised 1925.

Peanuts, white shelled Spanish.—Recommended 1923; revised 1925.

Peanuts, runner.—Recommended 1925; revised 1925.

Pears.—Recommended 1924; revised 1925.

Peas, fresh.—Recommended 1926.

Peppers, sweet.—Recommended 1923.

Pineapples.—Recommended 1924.

Plums and prunes.—Recommended 1923; revised 1926.

Potatoes.—Recommended 1917; revised 1926. (See S. R. A. 93 (Agr. Econ.) Amend. 2.)

Potatoes, sweet.—Recommended 1920; revised 1926.

Radishes, bunched.—Recommended 1926.

Spinach.—Recommended 1925; revised 1925.

Strawberries.—Recommended 1918; revised 1926.

Tomatoes, cannery.—Recommended 1923; revised 1926.

Tomatoes, fresh.—Recommended 1918; revised 1925.

Turnips, bunched.—Recommended 1924.

Watermelons.—Recommended 1923; revised 1925.

(Descriptions of these standards for fruits and vegetables appear in mimeographed circulars unless otherwise stated.)

Hay:

Timothy, clover, and grass hay.—Recommended 1922; promulgated 1925.

Alfalfa and alfalfa mixed hay.—Promulgated 1925.

Prairie hay.—Promulgated 1925.

Johnson and Johnson mixed hay.—Promulgated 1925.

Mixed hay.—Promulgated 1925.

(All hay standards in Handbook H. F. S. 540.)

Meats (fresh and frozen carcass beef).—Promulgated 1926. (See S. R. A. (Agr. Econ.) 99 and Dept. Bul. 1246.)

Soy beans.—Recommended 1925; revised 1926. (Mimeographed circular.)

Tentative Standards:

(*Used in services offered under annual appropriation acts covering inspection of hay, poultry, butter, and other perishable farm products*)

Eggs.—Recommended 1923; revised 1925. (Mimeographed circular.)

(*Used in services offered under annual appropriation acts; in market news work; basis for contracts by public institutions*)

Meats:

Fresh and frozen veal.

Fresh, frozen, and cured pork.

Fresh and frozen lamb.

Fresh and frozen mutton.

(Mimeographed circulars.)

Tentative standards—Continued.

(*Used in market news work and educational and demonstrational work*)

LIVESTOCK:

- Cattle, slaughter, stockers, and feeders. (See Dept. Bul. 1464. In press.)
- Calves, slaughter and stockers. (Mimeographed circular.)
- Hogs, slaughter, stockers and feeders.
- Sheep, slaughter, stockers and feeders.
- Lambs, slaughter, stockers and feeders. (Not yet available for distribution.)
- Standard schedule of market classes and grades of cattle, calves, hogs, sheep, and lambs. (See Dept. Bul. 1360.)

BUREAU OF ANIMAL INDUSTRY

Members of the bureau represent the department on six technical committees of the Federal Specifications Board.

Standards for Beef and for Color of Beef.—Standards for beef cattle and for color of beef are in use by the animal husbandry division in cooperation with States in judging breeding, fat, and feeder beef cattle and beef.

Color of Beef.—A set of colors characteristic of the color of meat from adult beef 30 minutes after cutting, is in use, as is also a tentative set of colors characteristic of the color of meat from adult beef immediately after cutting.

There is being prepared a set of tentative colors for (*a*) cooked meat and (*b*) fat of beef.

Standards for Dips and Disinfectants.—Under authority of the Secretary of Agriculture, embodied in Bureau of Animal Industry order No. 292, based on acts of Congress therein quoted, officials and employees have been duly appointed, to assure that only properly compounded products are employed in official dipping and disinfection under the supervision of the Bureau of Animal Industry.

The nature of materials standardized—disinfectants for stock cars, premises, etc., lime-sulphur and nicotine dips for cattle and sheep scabies, and arsenical dips for fever tick of cattle, are regulated by setting specifications for the composition and performance of these materials, by requirement of guaranty from manufacturers, by analysis and test of samples submitted by manufacturers, and by analysis and test of samples of such products collected in the field.

Standards for Veterinary Biologic Products.—In its regulatory work covering the production of veterinary biologic products, the Bureau of Animal Industry uses standards for measurement, doses for tuberculin, and strengths of tetanus antitoxin and botulinus antitoxin.

BUREAU OF CHEMISTRY

Members of the bureau represent the Department of Agriculture on 11 technical committees of the Federal Specifications Board.

Joint Committee on Definitions and Standards for Food Products.—The Joint Committee on Definitions and Standards for Food Products is appointed by the Secretary of Agriculture. It is comprised of 3 representatives of the Association of Official Agricultural Chemists, 3 representatives of the American Association of Dairy, Food, and Drug Officials, and 3 representatives from the Department of Agriculture.

Its functions are to recommend definitions and standards of purity for food products and to determine what are adulterations therein for the guidance of officials of the various States and for the Department of Agriculture in the enforcement of the Federal Food and Drugs act. It collects information and data upon methods of manufacture, treatment, and composition of food products; it formulates and publishes for comment and criticism tentative definitions and standards, holds public hearings to which the industries concerned and all interested are invited, and after full discussion and final revision recommends definitions and standards for food products to the Secretary of Agriculture for adoption. These, when approved, are published through the Office of the Secretary in the form of food inspection decisions.

Among the subjects under present consideration are ice cream, malted milk, sweet cream butter, alimentary pastes, cream corn meal, and special process cheese.

In the fiscal year 1926, definitions and standards were promulgated for sauerkraut, almond paste and kernel pastes, wine vinegar, grape vinegar and malt vinegar, milk and its products, glucose, Dutch-process chocolate and Dutch-process cocoa, fruit and fruit products, flour, meat, and the principal meat products.

Tea Standards.—The United States Board of Tea Experts is appointed by the Secretary of Agriculture, and consists of seven members, each of whom is an expert in teas. (See section 2, "An act to prevent the importation of impure and unwholesome tea," approved March 2, 1897, as amended.)

The United States Board of Tea Experts selects samples of teas to serve as standards, with which all teas entering the United States must be compared for purity and quality, and if found below the standards in purity or quality the teas are rejected.

The tea board is appointed on or before February 15 of each year, and meets in New York City or at a place designated by the Secretary of Agriculture. Samples suitable for standards are submitted by the trade. From these samples the tea board selects standards representing the primary kinds. All of these different kinds, as far as possible, are on a parity as to purity and quality. After these standards are fixed by the Secretary, they are packed in half-pound sealed containers and distributed to the tea examiners in the tea-

inspection service, and are sold to the tea-importing trade. The tea board also recommends to the Secretary any change that might be necessary in the regulations to properly enforce the tea act. While it is true that the tea board serves for one year and can be consulted at any time by the Secretary of Agriculture, normally, their activities cease after the standards are selected and fixed by the Secretary.

At the 1926 meeting the tea board selected seven standards, as follows:

Formosa Oolong (used for Foochow and Canton Oolong).
Congou.
Java (used for all fully fermented East India teas).
Young Hyson, green (used for all China green tea).
Japan.
Scented Orange Pekoe (used for capers).
Scented Canton.

Physical Standards for the Navy and Marine Corps.—The United States tea examiner at New York establishes standards of quality for the United States Navy, which are used in purchasing all teas for issue purposes by the Navy at the Brooklyn Navy Yard and elsewhere in the United States.

The supervising tea examiner at Washington fixes tea standards for the Marine Corps, which are used in purchasing all teas for issue purposes by the Marine Corps.

The office of supervising tea examiner also helps to get up the specifications for the purchase of teas by the General Supply Committee and the District of Columbia.

Tea Container Project.—The tea-inspection service is carrying on a research project testing out the keeping qualities of tea in more than 100 different types of tea containers. The information gained from this project is to be used by the division of simplified practice of the Department of Commerce in standardizing types of tea containers.

Standards for Naval Stores (Rosin, Turpentine, etc.).—In connection with its investigational and regulatory work on naval stores, the Bureau of Chemistry is charged by the Secretary of Agriculture with initiating the establishment of new standards for rosin and turpentine or the modification of existing standards. When the naval stores act went into effect on June 1, 1923, the permanent glass rosin types previously developed by the Bureau of Chemistry and three kinds of spirits of turpentine defined in the act were made the standards for naval stores until otherwise prescribed as provided in the act. The standards for rosin include the various grades of rosin, from highest to lowest, designated by the following letters, respectively, X, WW, WG, N, M, K, I, G, F, E, D, and B, together with the designation "gum rosin" or "wood rosin," as the case may be. The standards for turpentine include "gum spirits of turpentine," "steam-distilled wood turpentine," and "destructively distilled wood turpentine."

By section 3 of the naval stores act (42 Stat. 1436), the Secretary of Agriculture is authorized to establish and promulgate standards for naval stores for which no standards are therein provided, and to modify standards, for reasons and causes deemed by him sufficient, as the interests of the trade shall require.

The Bureau of Chemistry recommends for promulgation by the Secretary of Agriculture new standards or modified standards for naval stores in accordance with the provision of the act.

The regulations for the enforcement of the naval stores act, in regulation 5, dealing with section 3 of the act, describe the procedure for establishing new and modified standards, as follows:

Whenever in the opinion of the Secretary a standard is necessary for naval stores for which no standard is provided, or whenever for reasons deemed by him sufficient the interests of the trade require a modification of an existing standard, opportunities to be heard will be given those favoring or opposing the proposed standard or proposed modification of a standard. When the hearing is to be called for consideration of new standards, three months' notice in advance of the hearing will be given; when the hearing is to be called for consideration of the modification of an existing standard, six months' notice in advance of the hearing will be given. When a standard is established for naval stores for which no standard is provided, such standard shall become effective after three months from the date of the promulgation thereof; when an existing standard is modified such modification shall become effective after six months from the date of the promulgation thereof.

At the present time the Bureau of Chemistry is studying the color composition of wood rosins and considering the desirability of standards for wood rosin separate and distinct from those for gum rosin. It is also working on permanent color types for turpentines.

Through the Bureau of Chemistry, and in accordance with the procedure outlined in the regulations for the enforcement of the naval stores act (regulation 5), the Secretary of Agriculture promulgated the following standard for opaque rosin, effective May 15, 1926:

Opaque rosin is rosin which, because of its turbid, murky, or cloudy appearance, can not be graded under the other United States standards. The grade of such rosin shall be designated by the letters "OP," together with the designation "gum rosin" or "wood rosin," as the case may be.

The Bureau of Chemistry has one or more representatives on each of the following committees which work on the standardization of various products for identity and purity or by specification:

Joint committee on definitions and standards for food products, chairmanship and through representatives.

United States Board of Tea Experts, chairmanship.

Standardization of Methods.—The Bureau of Chemistry also cooperates with scientific societies, such as the Association of Official Agricultural Chemists, American Chemical Society, American

Leather Chemists' Association, American Society for Testing Materials, American Public Health Association, Committee on Revision, United States Pharmacopœia, American Drug Manufacturers Association, and American Pharmaceutical Manufactures Association, in the standardization of tests and analytical methods.

BUREAU OF PLANT INDUSTRY

Members of the bureau represent the Department of Agriculture on four technical committees of the Federal Specifications Board.

The Bureau of Plant Industry is not undertaking standardization of practices or products, but is concerned with several lines of activity involving clarification and stabilization of nomenclature of plants, both technical and commercial.

One case of this character which may be of interest is the cooperative undertaking of the American Joint Committee on Horticultural Nomenclature, in which the Bureau of Plant Industry participated, which resulted in the publication of the volume "Standardized Plant Names," published in December, 1923. This book was compiled by a subcommittee of three selected by, and was responsible to, the American Joint Committee on Horticultural Nomenclature, which represented the following organizations:

American Association of Nurserymen.
Ornamental Growers Association.
American Society of Landscape Architects.
American Pharmaceutical Association.
American Institute of Park Executives.
Society of American Florists and Ornamental Horticulturists.

The subcommittee also acted in cooperation with the following societies:

The American Dahlia Society.
The American Gladiolus Society.
The American Iris Society.
The American Peony Society.
The American Pomological Society.
The American Rose Society.
The American Seed Trade Association.
The American Sweet Pea Society.

The book is a catalogue of approved scientific and common names of plants in the American horticultural trade. It contains about 40,000 entries. It was published by the American Joint Committee on Horticultural Nomenclature.

Another cooperative line of work of a somewhat similar character is the official registration of new and improved varieties of wheat, oats and barley, which is carried on under a cooperative agreement between the Bureau of Plant Industry and the American Society of Agronomy. Under this undertaking a register of new and improved

varieties of wheat, oats, and barley is being developed and maintained, the varieties being so recorded as to origin and described as to significant characters that the register will be useful to originators and introducers of varieties of these crops, and to farmers and others interested in the general subject.

With reference to the clarification of the nomenclature, and looking toward the reduction in the number of varieties of fruits and vegetables grown in commercial plantings, such reduction being desirable in connection with the effort to standardize the commercial output of these products, considerable work has for some years been under way in our offices of horticulture. Most definite progress thus far has been made with respect to the varieties of potatoes and sweet potatoes. The results of comprehensive and careful varietal studies have been incorporated in publications in which the important groups of potatoes and sweet potatoes and the varieties composing these groups are described. Similar work is under way with peas, peanuts, and Jerusalem artichokes.

During the past year a tentative survey of the varieties of vegetables most extensively grown in commercial plantings has been made, the results of which indicate that fully 80 per cent of the commercial production of most kinds of vegetables is limited to four or five varieties of each. This autostandardization tends toward the reduction of the number of varieties and the stabilization of these on higher planes of productiveness and other desirable qualities.

BUREAU OF PUBLIC ROADS

Members of the bureau represent the Department of Agriculture on the following technical committees of the Federal Specifications Board:

Road and paving materials (chairman).
Rubber products.
Cements, lime, and plaster.
Drafting equipment and supplies.
Spraying machines (horticultural).
Lubricants and liquid fuels.

The bureau is represented on the American Engineering Standards Committee by the chief of the bureau, and also by membership on 13 American Engineering Standards Committee sectional committees in addition to holding sponsorship for the sectional committee on method of test for penetration of bituminous materials.

Cooperation with the American Concrete Institute consists in representation on and participation in the work of the committee on concrete aggregates. This committee is at present engaged in the preparation of standard specifications for aggregates.

The bureau is also represented on a joint conference committee of the American Association of State Highway Officials and the

American Railway Engineering Association on steel bridge specifications.

The bureau is likewise cooperating in the work of the Association of Asphalt Technologists, which is engaged in a study of asphalt paving problems with a view to the ultimate standardization of materials and methods of construction used in this type of pavement.

The bureau cooperates in standardization work with the American Association of State Highway Officials through representation on the committee on standards, the chairmanship of which is held by its representative. The main committee is divided into subcommittees and the bureau is represented by one or more of its members on the following: Committee on Design, Committee on Specifications, Committee on Construction, Committee on Tests and Investigations, and Committee on Bridges and Structures. This national organization is engaged in the preparation of standard specifications for materials used in highways and bridges and for methods of construction. Standard specifications thus far published, which have been approved by the Secretary of Agriculture for use on Federal-aid road work, are as follows:

Standard specifications for steel highway bridges.
Standard specifications for corrugated metal pipe culverts.
Tentative standard methods of sampling and testing highway materials.
Standards governing plans, specifications, contract forms, and estimates for Federal-aid highway projects.

FOREST SERVICE

Members of the Forest Service represent the Department of Agriculture on five technical committees of the Federal Specifications Board.

The Forest Service is a member of five American Engineering Standards Committee sectional committees and is a sponsor for specifications for railroad ties and methods of testing wood.

The Forest Service has membership on two committees of the American Society for Testing Materials.

American Chemical Society—Standard Cellulose Committee.—Membership to the copper number committee, appointed by the chairman of the standard cellulose committee, includes as chairman a Forest Products Laboratory chemist. The committee was appointed to recommend the best method for the determination of copper number in cellulose as one of the standard methods of cellulose analysis. Investigation of various proposed methods and the development of a method judged to be superior to those in general use have resulted from the work of this group. The results have been submitted to three referee chemists with a request for their opinion as to the best method to be used as a standard. The method

finally agreed upon will be recommended to the standard cellulose committee.

The chairmanship of the alpha cellulose committee is held by a Forest Products Laboratory chemist under appointment from the chairman of the standard cellulose committee. The purpose of the committee is to recommend a standard method for the determination of alpha cellulose. Study has been made of previously proposed methods with the result that a new method has been developed which will be proposed as standard to the standard cellulose committee.

American Wood Preservers' Association—Committee 4 (Preservatives).—This committee is responsible for the preparation of standard specifications for all wood preservatives and for methods of testing them. A Forest Products Laboratory chemist is a member of the committee.

Technical Association of the Pulp and Paper Industry—Sulphite Pulp Committee.—A member of the Forest Products Laboratory has been appointed to the committee by the president of the Technical Association of the Pulp and Paper Industry. The membership of the association votes upon committee recommendations.

The function of the committee is to recommend a standard method of testing sulphite pulp.

The procedure has been to conduct experimental work with different pulps and methods at various laboratories under correlation by the chairman of the committee. A ball-mill method has been developed, but not yet adopted.

American lumber standards program.—In addition to the standardization work performed by the Forest Products Laboratory staff members as individuals on standardization committees, the Forest Products Laboratory has contributed to the following projects of the American lumber standards program:

Softwood yard lumber standards.
Softwood factory lumber standards.
Hardwood factory lumber standards.
Structural timber standards.

Work in these fields on the part of the Forest Products Laboratory has initiated from specific requests from the General Lumber Standardization Conference, from the central committee on lumber standards, and from the latter's two consulting committees.

Such specific requests have involved technical studies in the laboratory and in the field of—

Thickness standards as affected by both use value and economies in production.

Short and odd lengths in standard specifications.

Moisture content and shipping weights as a basis for the application of size standards.

Basic grade or quality descriptions which classify the product of the log according to its highest use value and minimize waste in manufacture.

To get the basic data required, sawmill studies along various specific lines have been conducted in each lumber producing region. Construction and fabricating industry requirements have been secured by building and factory studies and by conferences with leading technical representatives of the industry.

The principal work under way at the present time has to do with the thickness and moisture content standards for softwood yard lumber and the basic grade descriptions for hardwood factory lumber.

During 1926, recommendations have been made along several of the above lines to the sponsoring organizations, particularly concerning the basic grades for hardwood lumber, in the development of which the industry as a whole is actively engaged. Trade opposition has been encountered, but the system proposed has advantages so worth while that its adoption by the industry stands as an objective toward which future efforts should and are being directed. Following an analysis and final report on industrial use of short length lumber the facts have been published as Department of Agriculture Circular No. 393, "Industrial Outlets for Short Length Softwood Yard Lumber."

Committee on Tree Names.—A standing committee of three members has long existed in the Forest Service to attempt to determine the best prevailing usage in tree and lumber names and to standardize this usage in the work of the Forest Service, and, so far as possible, outside. After consulting with various associations, companies, individuals, and interested technical bodies standard common tree and lumber names have been adopted by the Forest Service and will be used in its publications and recommended as the standard common names for trees and lumber throughout the United States. A revised edition of the "Check List of Forest Trees of the United States" is now in press.

Committee on Log Rules.—At the suggestion of the central committee on lumber standards, the Forest Service is making a survey of existing log rules, to determine the most accurate method of measuring and calculating the volume of a log, and will recommend to the central committee as a standard the rule or rules which give the volume most accurately. So far the results appear to indicate the superiority of a modified form of the "international rule" and of the cubic foot as a unit of measure.

Society of American Foresters and Association of State Foresters—Committee on Growth and Yield Tables.—This committee is composed of 9 members, 3 from the Society of American Foresters, 3 from the Association of State Foresters, and 3 from the Forest Service. The committee has for its object the setting up of accurate standard practices in the preparation of growth and yield tables for the various forest regions. These tables are based on large numbers

of measurements of trees of various sizes and ages and are designed to allow the landowner to predict the amount of timber of a given species that can be grown on a given area in a certain time. A report has been published in the Journal of Forestry. The methods outlined in the report have been accepted by the Forest Service as standard practice.

WEATHER BUREAU

Members of the Weather Bureau represent the Department of Agriculture on three technical committees of the Federal Specifications Board:

The bureau is a member of two American Engineering Standards Committee sectional committees.

The work of the Weather Bureau is connected only in an incidental way with matters of standardization. It is obvious, however, that in the collection of meteorological and climatological information from the continental areas of the United States and the cooperative reports from vessels traversing the oceans, certain standard methods are necessarily involved. These have been in force for many years and are briefly referred to in the following:

Atmospheric Pressure.—Land stations are equipped with mercurial barometers of an accurate and reliable type, all carefully adjusted and compared with fundamental standards at Washington, and, in general, stations are equipped with two instruments, compared with each other monthly for the purpose of checking up departures or deviations from standard pressure indications.

Elevation of barometers above sea level is very carefully standardized by geodetic measurements referred to mean sea level, and the standard method of reduction of barometric readings at elevated stations to a common sea level plane is in force, applicable to all continental stations. Changes in elevation that may occur by removal of office, or otherwise, are carefully referred back to the fundamental datum known as the "station elevation," which remains invariable, notwithstanding minor changes in location of the office or instruments.

Barometric Observations at Sea.—In this case the instruments used are owned by the masters of vessels. However, their indications are checked in port as frequently and completely as possible, to determine corrections required to reduce their readings to the barometric standard of the Weather Bureau.

Temperature Measurements.—These, also, are standardized by the distribution to all continental stations of the Weather Bureau of thermometers whose scale errors are accurately determined and corrections applied therefore, or whose errors are so small as to be negligible.

In the use of instruments for recording pressure, temperature, etc., uniform and systematic care is enjoined to determine from time to time, and apply, the necessary corrections, so that the automatic registration shall coincide as closely as practicable with eye readings with standard instruments.

The foregoing general methods of standardization of instruments apply to other instruments than those required for the measurement of pressure and temperature, and result in a homogeneous body of meteorological data collected by the Weather Bureau that is seemingly as free from variations and errors, depending on instruments, methods, and apparatus, as practicable.

Supplementing the foregoing, standard methods of exposure and installation of all types of instruments are enforced, so that the indications of the instruments, freed from their instrumental and inherent defects, are as representative as practicable of the true atmospheric conditions.

In the work in connection with river stages, flood conditions, etc., the same care is exercised in securing comparable and homogeneous reports, the conditions being referred to some invariable reference plane as completely as circumstances permit.

In the newer work of exploring the upper atmosphere by means of kites, balloons, etc., the same principle of standardization of methods and equipment has been carried out, so as to secure homogeneous observations and results.

Much of the procedure of standardization in the Weather Bureau was accomplished many years ago, and is maintained constantly and refined wherever required through the activities of the leaders in charge of the specific projects. No special organization exists for this purpose, although occasionally, where some particular subject, such as standardization of cloud observations, etc., is involved, a committee or board is appointed to analyze and report on the subject.

In the course of the development and reduction of the observations in the free air the bureau has supplied to the National Advisory Committee for Aeronautics the fundamental atmospheric data on which has been based the so-called "standard atmosphere."

DEPARTMENT OF COMMERCE

In addition to the Department of Commerce representation on Federal Specifications Board technical committees mentioned below, representatives from the following additional activities represent the Department of Commerce on the following number of technical committees:

Office of the Secretary, 2.
Coast and Geodetic Survey, 2.

BUREAU OF THE CENSUS

Standardization was first considered in connection with the work of the Bureau of the Census in 1903, when the collection of the financial statistics of cities, newly undertaken by the bureau, revealed and emphasized the lack of comparability in the city reports. The bureau, thereupon, called a conference of comptrollers and accounting officers, and at a second conference held in 1906 the National Association of Comptrollers and Accounting Officers was formed, having as one of its objects the installation of a uniform system of State and municipal accounting and reporting throughout the United States.

A standard classification of revenues, expenditures, indebtedness, and other financial statistics was prepared and submitted to the officials of the city governments, and this classification has been closely followed by many cities. It has also been approved by the Institute of Government Research, which is trying to introduce a uniform or standardized system of public accounting.

More recently, a similar organization of the State officials, the Association of State Auditors, Comptrollers, and Treasurers, has been formed to promote uniformity in accounting. A census advisory committee has been appointed in each of these associations to meet annually to bring about comparable financial statistics for the State governments and for the governments of the cities having a population of over 30,000.

BUREAU OF FISHERIES

Although the functions of the Bureau of Fisheries, as originally outlined, do not specifically provide for any standardization activities several such activities have become necessary as a means of carrying out the principal function. There are two activities of this bureau on standardization. First, standardization of trade names of fishes; second, the standardization of statistics collected on fisheries by various organizations.

From the very beginning of the bureau's work, it was necessary that common trade names of fishes be established in order to prevent confusion in all work pertaining to fishes, and particularly to statistical reports. Some idea of the confusion of names may be realized from the fact that there are more than 100 species of common commercial fishes taken in the United States, and that each of these may have from one to a half dozen common names, and that the same common name may be applied in different parts of the country to as many different kinds of fish. Standard names to be used for most species were, in the course of the early years of the bureau, established in its publications and statistical reports. But there have, until recent years, remained disputed questions. These were particularly acute in connection with proper labeling of products

under the jurisdiction of the Bureau of Chemistry. In order to clarify this situation, there was a committee appointed on January 13, 1917, by the commissioner, consisting of the commissioner, the deputy commissioner, chief of the division of scientific inquiry, chief of the division of fishery industries, and the ichthyologist of the Bureau of Fisheries. This committee, since its inception, has had about 50 meetings, at each of which one or more disputed questions of proper trade names were considered, and in most cases decisions were reached and communicated to the Bureau of Chemistry for its guidance in establishing their standard for the labeling of the products in question. The authority of this committee is purely advisory, but its activities, judging from results, have been adequately effective, so much so that in recent years it has infrequently been called upon to make further recommendations.

The collection by Federal agencies of fishery statistics has been conducted in a standardized manner since the beginning of these activities. They are, however, of insufficient continuity for the purposes of conservation data, and it is necessary that they be supplemented by statistics collected annually by States. This is being done at the present time by a number of States. The collection and publication of statistical data in the various States, however, is so diverse that some form of standardization must be accomplished before any compilation of the statistics of different States may be undertaken in order to show data relative to fishing activities covering regions extending over two or more States. The bureau is attempting to accomplish such standardization (1) by the encouragement of standard legislation by States requiring the statistics to be collected in the uniform method; (2) by a personal contact with State agencies collecting statistics; and (3) by supplementing in certain regions the statistics collected by the States by field work on the part of its own agents. During the past year these means of standardization have been employed in so far as possible and in the case of the Pacific Coast States standardization has, by these means, reached the point where compilations are now in progress for annual statistical reports on the fisheries of the Pacific Coast States.

BUREAU OF FOREIGN AND DOMESTIC COMMERCE

Members of the bureau represent the Department of Commerce on six technical committees of the Federal Specifications Board.

The Bureau of Foreign and Domestic Commerce is engaged in the collection and dissemination of information relative to the foreign and domestic commerce of the United States and other countries of the world. In the performance of these functions, there are answered an ever increasing number of inquiries, national and international in scope, concerning simplification of customs tariffs, commercial laws,

trade statistics, business practices, and standard specifications for materials. Further, its commodity and technical experts are called upon regularly to assist in the standardization and simplification projects being developed by public and private agencies.

The standardization activities of the bureau are largely of a cooperative nature, though some projects are initiated and promoted under its auspices, as may be seen from the following description of some of its work and accomplishments in this field.

For some years the initiative has been assumed in simplifying and standardizing the statistics of the foreign trade of the United States in comformity with the production data published by the Bureau of the Census and the Department of Agriculture. Statistical charts, table forms, indexes of prices, and other commercial movements have been simplified, and duplications of such statistical presentations by Federal agencies have been materially reduced. During 1926 an increasing effort was made to extend these activities to the international field through participation in international congresses and by conferences with representatives of foreign countries.

Commercially accepted specifications for materials have been translated, published, and distributed in foreign-language editions. This work was inaugurated about 10 years ago with French and Spanish languages series. Revisions and additions were made to the Spanish series during the last year, and a few standards were published in a newly inaugurated Portuguese language series.

Under the auspices of a representative advisory committee recommendations were promulgated covering standard methods for preparing paper wrapped parcel post and express packages.

Through another committee standard terms and conditions for general merchandise and cold storage warehouses were developed, and tentative instructions promulgated.

A Spanish-English glossary of automotive terms and one dealing with highway machinery and equipment were compiled for the purpose of assisting in the standardization of bilingual terminology in these industries.

Reports were issued concerning merchandising and trade conditions, trading laws, export packing, and other matters relating to the technique of foreign trade with the object of giving aid to exporters of commodities. These studies promote the normalization and standardization of trade practices and customs.

Through semiannual surveys of dealers' stocks of automobile tires conducted by the bureau, manufacturers were enabled to balance their production schedules, thereby eliminating waste through normalization of stocks of raw and processed materials.

In cooperation with the Department of Agriculture the tanning industry, farmers, stock raisers, and meat packers plans are under

way toward further improvement of hide and skin production through standardization of methods of take-off.

Members of the staff, versed in commodity and technical phases of domestic and foreign trade, continue to aid committees of the Federal Specifications Board in the development of standard specifications for materials purchased by the Federal Government.

Cooperation was also extended to the industrial committees of the division of simplified practice, Department of Commerce, in the development of a number of projects for reducing various commodities to common types, and for simplifying the sizes, classes, and grades of those commodities.

BUREAU OF LIGHTHOUSES

The Deputy Commissioner of Lighthouses is a member of the executive committee of the Federal Specifications Board, and members of the bureau represent the Department of Commerce on five technical committees of the Federal Specifications Board.

The bureau is a member of the American Engineering Standards Committee sectional committee on electrical installations on shipboard.

The Commissioner of Lighthouses has served for several years as the representative of the American Engineering Council on the "Joint Conference on Standard Contract Forms," a conference which has worked under the auspices of the Department of Commerce.

The superintendent of naval construction represents the Department of Commerce on the executive committee of the American Bureau of Shipping, in connection with the classification of vessels owned by the United States, in accordance with the merchant marine act of 1920 (sec. 25, 41 Stat. 988).

The superintendent of naval construction also is a member of two American Marine Standards Committee technical committees.

Aside from the above special designations, the Bureau of Lighthouses has no groups or individuals engaged strictly on standardization work. Various individuals of the bureau are, however, constantly engaged at work making improvements on apparatus and methods for the Lighthouse Service, which lead to a general standardization. Forty-six such individual items have thus been standardized.

Current standardization activities include the following:

- Acetylene cylinders.
- Radiobeacons and radiocompasses.
- Lights for aerial navigation.
- Vessel moorings.
- Iron and wooden buoys.

All superintendents of lighthouses (19) are, however, constantly at work making improvements on apparatus and methods for the Lighthouse Service, which lead to a general standardization.

BUREAU OF MINES

Members of the bureau represent the Department of Commerce on seven technical committees of the Federal Specifications Board.

The bureau is a member of 20 American Engineering Standards Committee sectional committees.

The bureau is also a member of the mining safety correlating committee and the safety-code correlating committee.

The work of the Bureau of Mines, extending as it does over the broad field of scientific, technologic, and economic investigations concerning the mining, preparation, and use of all mineral substances, with the object of increasing safety, health, efficiency, and economy in the mineral industries, is closely concerned with standardization of methods for testing, analyzing, and preparation of mineral materials. While its chief work is along the lines of pioneering research in developing new and efficient processes where these are lacking, and in building up and improving methods of extraction, recovery, and utilization, numerous instances could be given where the methods of analysis, testing, and specifications worked out and used in the bureau's laboratories have become standard practice for other investigative agencies. As a few of the more striking examples may be mentioned (1) methods for sampling, analyzing, and testing coal; (2) methods of analyzing explosives for mine use and testing for permissible use in coal mines; (3) methods for testing electrical mining equipment, lamps, and machinery to determine whether it can be safely used in atmospheres containing gas and coal dust in explosive proportions; (4) methods for analyzing and measuring rock dust in metal-mine atmospheres; (5) analytical method for comparing properties of different crude oils; and (6) methods of testing explosibility of coal dusts from different beds.

In the following paragraphs are described some of the investigations of the Bureau of Mines that relate directly to work where standardization of process or product is one of the principal objects sought.

Standard Methods for Sampling and Analysis of Coals.—The work of the coal analytical laboratory of the Bureau of Mines is carried on under authority of its organic act.

Its work consists chiefly of analysis of coals belonging to or for the use of the United States Government. The various executive departments and independent establishments of the Federal Government availing themselves of the opportunity to use the service laboratory are: The War, Navy, Treasury, Agriculture, Post Office, State, Labor,

Justice, Commerce, and Interior Departments; National Homes for Disabled Soldiers; District of Columbia; The Panama Canal; Panama Railroad; United States Coast and Geodetic Survey; and United States Shipping Board. Cooperative work is carried on with the States of Maine, Maryland, New York, New Jersey, and Virginia in connection with their purchase of coal on a specification basis, with various State geological surveys, with the Pennsylvania geological survey in the anthracite coal fields, and with the American Gas Association, and the American Society for Testing Materials. All coal analyses for different sections of the bureau are made in the laboratory.

The methods used are described in publications of the bureau, Bulletins Nos. 22, 85, 123, 193, 230, Analyses of Coals, Bulletins Nos. 116 and 119, Sampling of Delivered Coal, and others.

In the course of this work the methods used in the bureau's laboratories have been widely adopted in many laboratories, or are used as a standard check in comparing results of different laboratories. Samples are exchanged with several commercial laboratories for the purpose of checking their methods of analysis and to improve their standards. Referee analyses are often made.

Standard Crucibles for Coal Analysis.—The problem of comparing the illium and vitreosil crucibles with standard platinum crucibles for volatile matter determination was completed, and the report published in Fuels in Science and Practice (England) June, 1926.

Coal Ash Fusibility as Related to Clinker Formation.—Laboratory methods for determining the fusibility of coal ash have been carefully investigated by the Bureau of Mines in cooperation with the American Society for Testing Materials. The gas-furnace method developed was tentatively adopted as standard by the American Society for Testing Materials. The bureau is now making a comprehensive study to determine how accurately such laboratory tests predict clinker trouble experienced on burning coal. Seven different coals were carefully investigated as to ash composition and distribution, sulphur forms, and ash fusibility. The laboratory ash fusibility results on these coals were found to be indicative of the clinker trouble experienced in the burning of the coals. The results of the investigation are being compiled for publication. The work is being continued further on other coals.

Methods of Determining Sulphur in Coal and Coke.—In cooperation with committee D–5 on coal and coke of the American Society for Testing Materials, a careful study was made of the accuracy of various analytical methods for determining the sulphur content of coal and coke. It was found that the bomb-washing method and the sodium peroxide fusion methods if properly made were just as

accurate as the Eschka method, which has for a long time been used as a standard method for sulphur determination. The purpose of the cooperative work with the American Society for Testing Materials is to standardize methods of analyzing and testing of coal and coke, making the most accurate and workable methods available for use by laboratories engaged in analyzing coal and coke. Results are published in "The fusibility of coal ash," by A. C. Fieldner and W. A. Selvig; Fuel in Science and Practice, vol. 5, No. 1 (1925), pp. 24–33, and in "Relation of ash composition to the uses of coal," by A. C. Fieldner and W. A. Selvig, February, 1926, meeting of American Institute of Mining and Metallurgical Engineers.

Standard Analysis of Rock-Dusting Materials.—On account of the increasing use of rock dust in rock-dusting coal mines to prevent explosions of coal dust and gas, it is necessary that standard methods be available for testing such dusts for their effectiveness and possible effect on miners' health. The bureau's analytical laboratories analyze samples of shale, limestone, dolomite, gypsum, and other materials submitted by coal-mine operators for examination for suitability for rock-dusting purposes. Standard methods for making such analyses, and a table giving the composition of all samples of shale submitted were published as a chapter in Bulletin 21, Mining and Metallurgical Investigations, Carnegie Institute of Technology.

Standard Testing of Permissible Explosives and Permissible Mining Equipment.—Investigation having shown that the use of unsafe explosives had caused many mine disasters, the Pittsburgh station in 1908 began making tests to ascertain what explosives were least likely to ignite flammable gas or coal dust. As a result of the tests it approved certain explosives with short, quick flames as permissible for use in gaseous or dusty coal mines. As mine disasters had also been caused by the ignition of gas or dust by electrical equipment or mine lights, the tests for permissibility were extended to cover electric lamps, switches, motors, and flame safety lamps. The names of the articles that have passed the tests and the names of the manufacturers are published for the information of the public. This work is conducted with the voluntary cooperation of the manufacturers.

The system governing this work contemplates allowing the manufacturer to mark his goods with a seal bearing the name of the Bureau of Mines, and to state that they are "permissible" or "approved," provided the goods pass certain tests that are prescribed in published schedules. These tests are designed to insure the minimum requirements for safety according to the best judgment of the bureau. The submission of goods for tests is entirely voluntary. The bureau can not require a manufacturer to submit an article for examination; neither can it require mine operators or miners to use permissible supplies or equipment. For the conduct of examinations and tests,

a standard procedure is necessary. The bureau prescribes the conditions under which the tests are made and specifies the requirements that an article must satisfy to win the bureau's approval and be marked "approved as permissible." These conditions and requirements, as well as the fees charged to cover the cost of the work to the Government, are given in the schedules which are printed for free distribution. The schedules in force are as follows:

No.	Subject	Date issued
2B	Permissible motors	Aug. 26, 1920
4A	Permissible electric switches and junction boxes	May 9, 1922
6A	Permissible portable electric lamps	Feb. 3, 1915
7B	Permissible flame safety lamps	Sept. 19, 1922
8A	Permissible Methane indicators	Aug. 25, 1920
9A	Permissible telephones	Dec. 5, 1922
10A	Miscellaneous electric lamps	Feb. 2, 1916
11	Permissible flash lamps (methane)	Dec. 9, 1916
11, series 1-P	Permissible flash lamps (gasoline vapors)	May 6, 1925
12	Permissible single-shot blasting units	Apr. 11, 1919
15	Permissible locomotives	Aug. 16, 1919

These permissible schedules have become essential in guiding the activities of the bureau along safety lines, in giving the manufacturer of safety equipment a definite goal, and in placing the approval work on a firm foundation.

During the year, 16 approvals of mining equipment and apparatus have been made. Also 155 extensions of approvals have been issued.

The bureau's permissible list covers practically every line of activity for which equipment is used in underground coal mining. Electrically operated pumps and coal-loading outfits, were new lines added to the bureau's approval list during the year. Manufacturers are giving more and more attention to the designing of permissible mining machinery and the bureau looks forward to the time when operators will be able to efficiently equip their mines with a complete line of equipment which has been tested and listed by the bureau as permissible.

The bureau's specifications for permissible explosives were adopted as standard by the American Engineering Standards Committee in 1922.

A standard method for specific gravity study of ores by the sink-and-float method has been developed by the bureau.

A standard service test for refractories has been developed by the bureau.

Mine Accident Statistics.—With the cooperation of State officials and of individual operators the Bureau of Mines publishes reports dealing with accidents in the mineral industries. These reports give, by causes and States, the fatalities at coal mines and the fatal and nonfatal accidents at metal mines, quarries, coke ovens, and metal-

lurgical works other than iron blast furnaces. Compilation of figures on coal-mine fatalities began in 1910; that for metal mine and quarry accidents began in 1911; work on statistics at coke ovens and metallurgical plants began in 1913. Figures for coal-mine fatalities are published monthly and annually; figures for other accidents are published annually. The primary purpose of the bureau in collecting and publishing these data has not been to fix responsibility or to preserve a historic record of past experience, but to make available a body of reliable information from which legislative bodies and safety engineers can determine what are the hazards that should receive chief attention in the endeavor to increase the safety of workers. To further this purpose the bureau has advocated the use of standard forms for reporting accidents, and of standard methods of determining accident-frequency rates and accident-severity rates, so that the accident rates in different industries and in different States may readily be compared.

Wire Ropes for Mines.—The Bureau of Mines collaborated with the Bureau of Standards in the editing and revision of proposed rules for the use of wire ropes in mines, which has been presented by the American Mining Congress to the American Engineering Standards Committee as American standard.

Standardization of Petroleum Specifications and Methods for Testing.—After the outbreak of the World War, concern was felt in this country with respect to the available supply of petroleum products, and especially gasoline. The Bureau of Mines made some of the earliest and most comprehensive investigations of the motor-fuel situation, and as a result of these studies was able to advise the Fuel Administration of conditions within the petroleum industry.

The bureau had a representative on the Committee on Standardization of Petroleum Specifications, which was appointed by the President July 31, 1918. This committee was the forerunner of the present technical committee on lubricants and liquid fuels of the Federal Specifications Board.

Standardized Methods of First Aid Instruction have been developed to improve health conditions among those engaged in the mineral industries.

Standardization of Mine Rescue Methods and Rescue Apparatus.—The bureau, in conjunction with mine operators and manufacturers of rescue equipment, has developed improved types of oxygen-breathing apparatus that meet the severe test requirements formulated by the bureau engineers and surgeons on the basis of years of experience in mine-accident investigations and rescue work and tested out in actual service.

In 1916 the bureau issued its handbook on Rescue and Recovery Operations in Mines After Fires and Explosions, covering methods

and equipment used and recommended by the bureau. In 1921 an international conference of members of the Bureau of Mines, State mine bureaus, Mining Department of British Columbia, and the British Mines Department prepared a tentative standard procedure for mine rescue work that was issued as Technical Paper No. 334, "Mine Rescue Standards, a Tentative Study." The report covers rescue apparatus requirements and tests for permissibility, physical tests of rescue workers, and rules for use of rescue apparatus, and procedure to be followed at explosions and fires in coal mines and fires in metal mines.

Mine Safety Organization.—During 1926 work toward bringing about a standard system of mine safety organization for mines was promoted vigorously by the bureau's engineers.

Standard Code of Safety Rules for Installing and Using Electrical Equipment in Bituminous Coal Mines.—The Bureau of Mines, with a view to increasing safety in mining, published in 1916 its Technical Paper No. 138, containing a set of rules recommended by the bureau for installation and use of electrical equipment in bituminous coal mines. In cooperation with the standardization division of the American Mining Congress and the American Engineering Standards Committee, a revision of the code presented in the above paper has been completed during 1926 and is in course of publication as Technical Paper No. 402. These rules cover the installation and use of electrical equipment underground in coal mines.

Standardizing Methods of Reporting Metal Statistics.—The Bureau of Mines in its reports on mineral resources, production and consumption, and prices of minerals is working toward a standard method of reporting ores and concentrates based on metal content of the ore. For example, reports on mine production of lead and zinc concentrates in short tons and value per ton, but also the actual metal content of lead and zinc in short tons and its value per ton. All production figures for an industry are reduced to standard terms so that comparison can readily be made.

Mine Timber Standardization.—The Bureau of Mines cooperates with the American Mining Congress, the United States Forest Service, and the Pennsylvania Forest Products Manufacturers Association on work directed toward standardizing specifications for mine timbers and simplifying timbering practice in mines.

NATIONAL BUREAU OF STANDARDS

The director of the bureau is ex officio chairman, and a senior engineer-physicist of the bureau staff is vice chairman and technical secretary of the Federal Specifications Board.

Members of the bureau represent the Department of Commerce on 54 technical committees of the board.

For details of the organization and work of the Federal Specifications Board, see page 109.

The Director of the Bureau of Standards is chairman, and a physicist of the bureau is secretary, of the National Screw Thread Commission. For details see page 137.

The Bureau of Standards deals with standards and standardization in their broadest aspects. For selected details of the work see Chapter VI.

STEAMBOAT INSPECTION SERVICE

The supervising inspector general is a member of the American Marine Standards Committee.

The service is represented on two American Engineering Standards Committee sectional committees.

The bureau has had under consideration during the past year the matter of the standardization of the inspection of the material for boilers and the inspection of the completed boilers themselves, and to this end the service requested the American Marine Standards Committee to give attention to a comparison of the rules and regulations of the British Board of Trade, the British Corporation, the Bureau Veritas, British Lloyd's, the American Bureau of Shipping, and the American Society of Mechanical Engineers with the rules and regulations of the Steamboat Inspection Service with a view to adopting a code that would embody the best in all.

DEPARTMENT OF THE INTERIOR

In addition to membership on the technical committees of the Federal Specifications Board mentioned below, designations from the following additional activities represent the Department of the Interior on the technical committees mentioned:

Office of the Secretary, 1.
Division of supplies, 2.
St. Elizabeths Hospital, 5.

BUREAU OF RECLAMATION

An engineer of the bureau represents the Department of the Interior on the Federal Specifications Board. Members of the bureau represent the department on two technical committees of the board.

The bureau is a member of two American Engineering Standards Committee sectional committees.

Standardization work done in this bureau in the past, now in progress, and contemplated in the future, is limited to the development of designs and practices to be adopted as standards by this bureau only, for use on its several projects. In this the interests of this bureau are the controlling factors and cooperation with outside

interests in the matter have been largely incidental. Twelve standard designs have been made and are now in use.

GEOLOGICAL SURVEY

Members of the Geological Survey represent the Department of the Interior on six technical committees of the Federal Specifications Board.

The survey is a member of the American Engineering Standards Committee sectional committee on rating of rivers.

The Geological Survey has, for a number of years, been endeavoring, through committees, to standardize geologic formation names and scientific terms used in physiography. During the past year, progress has been made along these lines in the publications of the survey, and outside of the survey there has been manifested considerable interest in these subjects and a growing desire to conform to such standards, as far as possible.

The water resources branch of the survey has made material progress during the year in the standardization of instruments and methods used in obtaining records of river discharge.

NATIONAL PARK SERVICE

A member of the National Park Service represents the Department of the Interior on the Federal Specifications Board technical committee on road and paving materials.

The National Park Service has standardized road and other signs in use in the national parks, on monuments, and for other purposes.

OFFICE OF INDIAN AFFAIRS

Members of the Office of Indian Affairs represent the Department of the Interior on 11 technical committees of the Federal Specifications Board.

Members of the office are serving on the Interdepartmental Board on Simplified Office Procedure, on the Interdepartmental Board of Contracts and Adjustments, and on the Federal Purchasing Board.

Representatives of the office have also participated in several of the movements started by the division of simplified practice, Department of Commerce. Standardization has been effected in the Indian Service through the use of United States Government master specifications, standard forms of accounting, bills of lading, and Government transportation.

The office has effected a standardized system of filing in its field units, and in the main office, and by adopting the budget system to govern field appropriations, a standardized method of authorizing the expenditure of funds appropriated for the maintenance and operation of field activities has been accomplished.

The office is adopting, as far as it is practicable to do so, the simplified-practice recommendations of the Department of Commerce.

DEPARTMENT OF LABOR

The Department of Labor is represented on the executive committee, Federal Specifications Board, by the first aide.

The department is represented on the Federal Specifications Board technical committee on beds and bunks.

The department, as such, is represented on 28 American Engineering Standards Committee sectional committees.

BUREAU OF LABOR STATISTICS

The Commissioner of Labor Statistics represents the Department of Labor on the executive committee and the main committee of the American Engineering Standards Committee. By arrangement with the latter organization the workers' representatives on safety-code committees are selected and appointed through the Department of Labor.

The Commissioner of Labor is secretary-treasurer of the International Association of Industrial Accident Boards and Commissions, and appoints representatives of that association on American Engineering Standards Committee safety-code committees.

The bureau is represented on the American Engineering Standards Committee safety-code correlating committee.

CHILDREN'S BUREAU

The Children's Bureau is primarily a research bureau in the whole field of child welfare, and it is a center of information useful to all the children of America, to ascertain and to popularize just standards for their life and development, to serve all children, and to endeavor to work out the standards of care and protection which shall give to every child his fair chance in the world.

WOMEN'S BUREAU

It is the duty of the Women's Bureau, in the interest of health measures for women workers, to study the problems surrounding their employment and to draw up standards designed to make industry safe for women.

NAVY DEPARTMENT

BUREAU OF AERONAUTICS

A member of the bureau represents the Navy Department on two technical committees of the Federal Specifications Board.

Three years ago, as a result of correspondence between the Chief of the Army Air Corps and the Chief of the Bureau of Aeronautics, two officers were appointed, one an Army Air Corps officer of the engineering division, McCook Field, Dayton, Ohio, and the other

an officer of the Bureau of Aeronautics, to work on the problem of bringing the material specifications and the standard-parts drawings of the two services into agreement. The function of these officers is wholly advisory. They consider the various items used by the two services, decide on a means of bringing the requirements into accord and recommend to their respective services that plans and specifications be altered to bring about standardization. Those which are approved become Army-Navy aircraft standards, or AN standards, are drawn up as master drawings and specifications, and bear the signature of the chief engineer, engineering division, Army Air Corps, McCook Field, and of the head of the design section of the Bureau of Aeronautics. They then serve as master drawings and specifications for the two services in the same manner as the Federal specifications.

This work is being handled by means of an annual conference. To this conference are invited airplane manufacturers, part manufacturers, representatives of the aeronautic standards committee of the Society of Automotive Engineers, as well as representatives of the various branches of the two services interested. Prior to these meetings it has been customary to invite those interested to submit suggestions as to subjects for standardization. Based on these and the ideas of the two service representatives, a tentative program is drawn up. As much of this program as is possible in the time allotted is discussed at the conference. The 1926 AN conference was held in Washington.

Seven AN standard drawings were promulgated July, 1926.

Eleven AN specifications were agreed upon at the 1926 conference.

Fifty-three AN standards were issued up to July 1, 1926.

The following list indicates, in a general way, fields as yet untouched for which it is hoped that AN standards may be adopted in the future:

- Armament.
- Electrical equipment.
- Power plant.
- Propellers.
- Instruments.
- Personnel equipment:
    - Parachutes.
    - Flying clothing.
    - Goggles.
- Photographic equipment.

BUREAU OF CONSTRUCTION AND REPAIR

Members of the bureau represent the Navy Department on 30 technical committees of the Federal Specifications Board.

The bureau is represented on six sectional committees of the American Engineering Standards Committee.

The bureau is a member of the American Society for Testing Materials and the American Marine Standards Committee.

In addition to representation on the organizations above mentioned the bureau has cooperated in numerous standardization projects undertaken by other similar agencies as listed below:

With the division of simplified practice, Department of Commerce, whenever materials in which this bureau is directly interested are taken up. Many of the division's recommendations have already been put into effect.

With the National Lumber Manufacturers' Association and other lumber organizations with a view to using the recently established American lumber standards as a basis for purchase. For nearly a year the bureau has utilized standard commercial specifications and certified commercial inspection in lumber procurement.

With the National Screw Thread Commission by putting into effect the new national form of thread on all threaded products.

With the flag standardization committee and the Commission of Fine Arts in standardizing the proportions and colors of the national ensign. The bureau is also engaged in standardization of colors of all flags and pennants, in connection with the color committee of the Federal Specifications Board.

The bureau, in its own work, is carrying on a continuing review of the standard stock catalogue with a view to reducing multiplicity of sizes, shapes, and grades of stock items.

Many tests are under way in the various navy yards and stations for the purpose of obtaining technical data as a basis for further standardization and improvement of materials, such as cordage, locks, rubber products, bolts and nuts, hand tools, paint brushes, beds and bunks, hose couplings, pipes and tubing, aluminum alloys, etc. In all such work the bureau freely consults all established commercial standards and practices with a view to advancement of the standardization movement. The bureau has been carrying on a considerable volume of experimental work in conjunction with the National Bureau of Standards on strength and design of riveted joints, elastic qualities of shipbuilding steels (domestic and foreign), and on behavior under load of blocking in dry docks.

BUREAU OF ENGINEERING

The assistant chief of the bureau represents the Navy Department on the executive committee of the Federal Specifications Board, and various members of the bureau represent the Navy Department on 18 technical committees of that board.

The bureau is a member of the executive and main committees of the American Engineering Standards Committee, and is represented on 17 sectional committees of that body.

A member of the Bureau of Engineering, jointly with a member of the Bureau of Ordnance, represent the Navy Department on the National Thread Commission.

The bureau is represented on the marine committee of the American Institute of Electrical Engineers in the consideration of revision of marine rules and revision of standards for electrical installations on shipboard.

The bureau is a member of the committee on standardization of machine-tool elements of the American Society of Mechanical Engineers, which is considering:

Proposed standards for tool holders and tool post openings in circulation.

Completed standardization of T slots for machine tools.

The bureau is a member of the executive board of the American Marine Standards Committee and also a member of 11 subcommittees of that body.

The bureau is a member of the American Society for Testing Materials and four committees of that body.

The bureau is a member of the chief coordinator's committee on communications, for outlining the field to be covered by the Commerce and Navy Departments relative to radio and sound aids to navigation and radiocompasses, and is a member of the inter-department radio advisory committee for the consideration of adjustments of frequencies to avoid or reduce interference between Government radio stations.

The bureau is a member of the American National Committee of the International Electro-Technical Commission, and is a member of the joint committee on investigation of the effect of phosphorus and sulphur in steel, with other activities.

BUREAU OF MEDICINE AND SURGERY

Members of the bureau represent the Navy Department on seven technical committees of the Federal Specifications Board.

Three activities of the Bureau of Medicine and Surgery contribute to formulation of standards.

1. The planning and publications division is particularly charged with investigation of means for improvement of procedure and material. This division prepared a new supply table for the medical department based on an analysis of the rate of use of medical and surgical material throughout the Navy. Fifty items were eliminated. Through the standardization of surgical instrument cases, cabinets, rolls, etc., by the naval medical supply depot, the sizes of scalpels previously listed were reduced to three, and the number of surgical scissors to six. The supply table items were listed to conform to commercial practice and agree as closely as possible with those listed by the Army. The new table also made for a standard method of stock keeping by all medical activities of the Navy. Officers of the planning and publications division serve

as members of the above-mentioned technical committees of the Federal Specifications Board and have acted in an advisory capacity to other committees charged with matters of interest to the medical department, such as beds, clinical thermometers, sterilizing equipment, etc.

The Naval Medical Supply Depot in Brooklyn, N. Y., maintains chemical, physical, bacteriological, and electrical laboratories for testing medical supplies and equipment purchased for the Navy and for the Veterans' Bureau. The laboratories are equipped to test a large variety of materials ranging from drugs and chemicals to alloys, textiles, rubber goods, X-ray equipment, and clinical instruments of precision. Here standards are established for specifications under which purchases are made. Federal specifications are used by this depot as soon as they are promulgated. The supply depot's laboratories have been of great help to members of several technical committees of the Federal Specifications Board in formulating standards. In the physical laboratory a new method for measuring the adhesiveness and probable life of adhesive plaster was developed. The rubber section of the National Bureau of Standards assisted by timely advice in extending the use of its facilities in the preliminary work. The X-ray laboratory has standardized X-ray equipment, spare parts, and supplies for the naval service with appreciable saving to the Government.

The Naval Medical School, Washington, D. C., maintains chemical, clinical, and bacteriological laboratories for research, diagnosis, and instruction. As a result of work conducted at this school a standard method of conducting the Kahn precipitation test for syphilis has been adopted for the Navy. This is of legal as well as clinical importance in connection with pensions.

Tests on steam sterilizers of the vacuum and nonvacuum type were conducted by the Naval Medical School for the technical committee on sterilizing equipment, Federal Specifications Board. Through the courtesy of the Director of the National Bureau of Standards, that bureau calibrated the gauges and a representative conducted thermal measurements. As a result of the tests it is apparent that a temperature-recording device should be provided in addition to pressure gauges, and that manufacturers' directions should be standardized in order to insure sterilization. A remarkable feature of the tests was the serious temperature deviations in the sterilizer chamber from the normal pressure-temperature ratios when operated according to the manufacturer's printed directions.

BUREAU OF NAVIGATION

A member of the bureau represents the Navy Department on the Federal Specifications Board technical committee on wearing apparel (nonmilitary).

Naval Observatory.—The Naval Observatory at Washington, D. C., sends out daily the time signals which establish standard time for the country and enable the mariner at sea to ascertain his chronometer error and his longitude by observation. The signals are transmitted by the Naval Radio Stations at Arlington, Annapolis, and Key West, and the noon signals by land wire also. Similar service for the Pacific coast is furnished by the Naval Chronometer and Time Station at Mare Island, Calif. Special signals are sent by the Naval Observatory for use of United States and foreign scientific institutions, astronomical work, surveying, eclipse, and longitudinal expeditions.

The observatory prepares specifications covering the purchase of navigational instruments. The specifications are designed to insure the purchase of instruments of high-grade quality and workmanship.

The ordinary navigational instruments, such as magnetic compasses, peloruses, etc., have long been standardized, but improvements are incorporated in them from time to time. Attempts are being made to standardize aircraft navigational instruments, but owing to the constant improvements which are being made in these instruments, the observatory is not yet in a position to adopt any particular type as standard.

World Longitude Determination.—The following memorandum for observatories in the United States, and near-by regions, was prepared and distributed by the United States Naval Observatory, Washington, D. C., during the year 1926:

There will be a world longitude determination by radio signals, beginning October 1, 1926, and ending December 1, 1926. This project, proposed several years ago, has the approval of the International Astronomical Union and of the International Geodetic and Geophysical Union.

The principal stations of the so-called "fundamental polygon" will be at the Naval Operating Base, San Diego, Calif., at the Algiers Observatory, and at the Shanghai Observatory. These stations are at nearly the same latitude, and are spaced approximately eight hours apart in longitude. It is proposed to determine the differences of longitude with great accuracy, and to make redeterminations at intervals sufficiently separated in time in order to test the permanency of their relative positions, and certain possibilities as to movement of the earth's crust.

It is expected that many other observatories will join in this operation, including Washington, Greenwich, Paris, and Australasian observatories. The United States Coast and Geodetic Survey proposes to occupy stations at Honolulu and Manila.

The radio signals will be of the so-called rhythmic type, so spaced that there will be 61 signals per minute for 5 minutes, 306 in all. They will be sent at three periods of the day, Greenwich time, as follows:

Station	Wave length	Greenwich time
		h m h m
Annapolis	17,145 meters	20 10 to 20 15 3 10 to 3 15 10 10 to 10 15
Arlington, or Bellevue (near Washington)	74.7 and 24.9 meters	20 20 to 20 25 3 20 to 3 25 10 20 to 10 25
Honolulu	11,500 meters	20 30 to 20 35 3 30 to 3 35 10 30 to 10 35
Do	36.8 meters	20 40 to 20 45 3 40 to 3 45 10 40 to 10 45
Saigon	17,000 and 25 meters	11 30 to 11 35 19 00 to 19 05
Bordeaux	18,900 meters	8 01 to 8 06
D'Issy (near Paris)	32 meters	20 01 to 20 06 8 01 to 8 06 20 01 to 20 06

It is suggested and urged that as many astronomical observatories as can arrange to do so, make time observations and receive the signals, thus enabling them to establish their longitudes with reference to one or more of these points of reference. The radio signals may be received automatically on a chronograph, a method which has some obvious advantages, or by ear by the coincidence or other methods. Short-wave signals are sent as well as long-wave signals, as some observers report better reception by the short waves, especially at very distant stations when there is not much daylight between the stations.

The Annapolis and Arlington (or Bellevue) signals will be the principal ones by which observers in this country can connect directly with Washington. These signals will also probably give a direct connection with Greenwich and Paris, as will also the Bordeaux signals.

The International Astronomical Union recommends that in the reductions the star places of the American Ephemeris be used as far as possible, and that clock stars be confined to the region 20 or 25° north and south of the zenith.

Any inquiries regarding the work will gladly be answered by the United States Naval Observatory, Washington, D. C.

Hydrographic Office.—The work of the Hydrographic Office calls for standardization along special lines which is carried on between

other executive departments under authority of Executive Order 30, September, 1919, creating the Board of Surveys and Maps, in which the office has membership for the purpose of coordination, and the standardization of its chart and map construction.

The office also maintains membership on the United States Geographic Board for the purpose of standardizing names entering into its charts and publications.

The office maintains close cooperation with the hydrographic services of all foreign nations and maintains complete exchange of all publications in accordance with general practice. In 1921, the International Hydrographic Bureau was established for the purpose of standardizing and making uniform the practices of the Hydrographic Office maintained by the various nations, of which the United States is a member and at present has a member on the governing board of three.

The Hydrographic Office is represented on the American Engineering Standards Committee sectional committee on colors for traffic signals.

Through the coordinating agencies mentioned above, effort is constantly directed toward standardization of forms, symbols, characters, and methods of surveying, chart construction, and publication of nautical books.

BUREAU OF ORDNANCE

During the year 1926 the Bureau of Ordnance has taken an active interest in standardization work.

Members of the bureau represent the Navy Department on two technical committees of the Federal Specifications Board.

The chief of the bureau is a member of the American Engineering Standards Committee, and the bureau has contributed to the movement by the assignment of officers and civilian engineers to specification boards which are engaged in working out standards for materials which are used in ordnance equipment.

Officers assigned to specification boards or committees are appointed by the chief of the bureau with full authority to act for the bureau. In the case of the Federal Specifications Board technical committee designations, the individual designated represents the Navy Department. The officers generally are chiefs of design sections of the bureau, and appoint civilian engineers as their assistants.

During the year, a large number of specifications in the form of drafts and finished specifications have passed through the bureau. All Navy Department specifications are referred to the bureau as they are required to be approved by the chiefs of all bureaus before

they are printed. The drafts of all Federal specifications are also referred to the bureau for comment.

The handling of the correspondence in connection with Navy Department specifications between the various bureaus of the department and the drafting of new and revised specifications, is greatly facilitated by the use of special procedure which was worked out by the Navy Department specification board, and which is being followed by all bureaus. The procedure includes a standard form for specifications, the circulating of advance copies of the draft which insures prompt action by the various bureaus on the original, directions for routing drafts and proofs, and the forwarding to the secretary of the Navy specifications board a copy of all correspondence and, every two weeks, a report on a special form showing all specifications received, date of receipt, date forwarded, and the routing of the correspondence.

Each Navy Department specification passes through each bureau at least twice before final printing—once in the form of a draft and once as a page proof. During the year there were, on the average, about 150 specifications in the process of preparation, and the combined number of drafts and proofs which were referred to the bureau was approximately 700.

A member of the Bureau of Ordnance, jointly with a member of the Bureau of Engineering, represent the Navy Department on the National Screw Thread Commission.

BUREAU OF SUPPLIES AND ACCOUNTS

Members of the bureau represent the Navy Department on 11 technical committees of the Federal Specifications Board.

That part of the standardization work in which the bureau is engaged which relates to the general subject of standards and standardization, consists of the preparation and promulgation of Navy standard specifications on items over which this bureau has cognizance.

During 1926, 39 new and revised specifications, and four revisions of the "Index to Specifications," have been issued.

BUREAU OF YARDS AND DOCKS

Members of the Bureau of Yards and Docks represent the Navy Department on 14 technical committees of the Federal Specifications Board.

The bureau is cooperating with the metals committee, Federal Specifications Board, on research on galvanizing, in conjunction with the Washington Navy Yard, the New York Navy Yard, the National Bureau of Standards, and the New Jersey Zinc Co.

The bureau cooperates in connection with the simplification program of the division of simplified practice, Department of Commerce.

The bureau is represented on eight sectional committees of the American Engineering Standards Committee.

A member of the bureau represents the Navy Department on the slate committees of the American Society for Testing Materials, and the bureau is cooperating with that society on long-time experiments on galvanized metal at Key West, Fla.

The bureau is cooperating with various tin-plate manufacturers, can manufacturers, and the National Canners' Association on its research program, and is conducting experiments at Pearl Harbor, Hawaii, and Portsmouth, N. H., to establish standards for concrete in sea water. The bureau has a representative on the Navy specification board, revising the Navy General Specifications for Inspection of Materials.

In addition to the above memberships held by Navy Department bureaus on sectional committees of the American Engineering Standards Committee, the Navy Department, as such, is represented on 11 additional sectional committees of that body.

UNITED STATES MARINE CORPS

The assistant quartermaster, United States Marine Corps, represents that body on the Federal Specifications Board, and members of the Marine Corps represent that body on seven technical committees of the board.

The Marine Corps standardization work is closely coordinated with that work in the Navy Department proper. The Navy Standard Specifications for Materials and Supplies are used.

The following standardization of truck transportation has been approved and adopted by the quartermaster for the Marine Corps:

For extra light truck transportation and replacement of motor cycles with side cars (whenever advisable and practicable)—½-ton truck commercial roadster type, with steel pick-up freight body.

For light truck transportation—¾-ton truck, with Marine Corps canopy express body, until supply in stock is exhausted; thereafter 1-ton truck, with Marine Corps canopy top express body.

For medium truck transportation—1½-ton truck, with canopy top express body.

For heavy truck transportation—(*a*) 3-ton truck, with class A cargo or dump body, until supply in stock is exhausted; (*b*) standard B 3 to 5 ton truck, with class B cargo or dump body.

The standardization of trucks under classes 1, 2, and 3 will be effected by the gradual replacement of the obsolete and older types of trucks as they become worn out, unserviceable, and uneconomical to repair and maintain.

A new Marine Corps automobile enamel has been adopted as the standard paint for Marine Corps motor vehicles. Since there is on hand a large amount of olive drab paint, the newly adopted Marine Corps enamel will be used only in painting passenger cars. The olive drab paint will be used on trucks until the supply is exhausted; thereafter all motor vehicles will be painted with the standard enamel paint. The shade of this enamel is that approximating the color of the winter service uniform.

POST OFFICE DEPARTMENT

The Post Office Department is represented on the Federal Specifications Board by the superintendent of the division of equipment and supplies.

Members of various divisions represent the department on 21 technical committees of the board.

The Post Office Department is represented on American Engineering Standards Committee sectional committee on safety code for aeronautics.

FIRST ASSISTANT POSTMASTER GENERAL

Division of Post Office Quarters and Engineering.—This branch of the Postal Service has jurisdiction over the selection, equipping, and leasing of quarters for presidential post offices and stations thereof (except those located in Federal buildings, which are under the jurisdiction of the Supervising Architect of the Treasury Department); the consideration of the practicability of devices and inventions in the Postal Service, including the designing and construction of buildings, etc.

Standardization in this work has been in process for several years and the United States Government master specifications promulgated by the Federal Specifications Board are used where applicable.

Division of Motor Vehicle Service.—This branch of the Postal Service has jurisdiction over the authorization, operation and maintenance of the Government-owned motor vehicles service, and the materials, supplies, and garage equipment pertaining thereto.

The standardization of types and sizes of motor vehicles and materials and supplies used therewith, has been progressing for several years. United States Government master specifications promulgated by the Federal Specifications Board are used where applicable.

SECOND ASSISTANT POSTMASTER GENERAL

Air Mail Service (Government-Operated).—During the year the Post Office Department has purchased 50 mail-carrying planes for use in the Government-operated service between New York and San Francisco, with a weight-carrying capacity approximating 800

pounds each. The planes purchased are known as the Douglas *M–4* mail planes.

The type of engine used in these mail planes is the Liberty 12, which has been secured from the surplus war stock of this type engine.

On the lighted portion of the transcontinental route there has been installed a lighting unit known as the aeroelectric, whose source of power is the force of the wind exerted against a specially constructed propeller, the energy being stored by means of batteries. This unit eliminates the need of caretakers at points where these beacon lights are installed.

By standardizing equipment, such as planes, engines, and lighting, the cost of operating the service has been reduced to a very great extent.

Cars, Railway Post Office, Full and Apartment.—On June 30, 1926, there were 902 full railway post office cars and 4,068 apartment cars. Three new steel full mail cars, 78 new steel mail apartment cars, 22 new steel motor mail apartment cars, and 4 new steel trailer mail apartment cars were built during the year.

One hundred and forty-one cars (29 steel full mail cars, 77 steel-underframe mail apartment cars, 34 wood steel-reinforced mail apartment cars, and 1 wood mail apartment car) were standardized, 64 apartment cars made practically standard, and 1,144 other full and apartment mail cars were made more nearly standard.

Considerable progress has been made toward standardizing mail cars and making them safer for service requirements, improving them in such manner as to facilitate the distribution of mail, in the way of additional lamps, substituting electric lamps for gas and oil, opal glass reflectors in place of metal, etc.

The specifications for the construction of steel full and apartment mail cars and for fixtures therein were revised during the present year and issued to all concerned. Electric fans were included in the specifications, to be furnished when deemed necessary.

FOURTH ASSISTANT POSTMASTER GENERAL

Post-office equipment and furniture have been standardized, and drawings for same have been made available. This makes it possible for the department to secure better and more uniform equipment than heretofore, and it can be purchased more cheaply and used to better advantage.

Two types of standard safes containing a burglar-proof chest have been adopted and specifications drawn as a result of conference with experts of the National Bureau of Standards. Tests have been conducted by the National Bureau of Standards on several safes

36316—27——7

manufactured in accordance with the specifications, and the department is assured that safes meeting said specification and passing the tests referred to will be entirely satisfactory for use in the Postal Service. The safe specifications conform to the Federal specifications covering safes and burglar-proof chests.

This department has standardized on a reinforced concrete post for letter boxes. The adoption of this new type of post has resulted from the assistance afforded by experts of the National Bureau of Standards and data supplied by cement manufacturers. Steel and iron posts have been used heretofore. These are subject to corrosion, particularly along the seaboard; this is eliminated by the use of cement posts. A simple form of test for strength, which is used at the plant of the contractor, has also been adopted.

Specifications have been adopted defining a defective sack or pouch as applied to the Postal Service. This reduces to a minimum the number of bags forwarded to the mail equipment shops at Washington for repair.

A system has been devised whereby the accumulation of defective mail bags throughout the country is released for shipment to the mail equipment shops at Washington periodically and in such quantities as eliminates the storage of large quantities of mail bags at the shops, thereby releasing valuable space for other uses.

A zinc grommet has been adopted for use generally in mail bags in lieu of a tinned steel grommet, due to the fact that the zinc grommet will resist rust and can be more economically manufactured.

A standard, individual sewing-machine buck (stand) has been designed and is in use in the mail equipment shops.

It has been found that such an arrangement leads to greater flexability in arrangement of machines and in conservation of space.

PURCHASING AGENT

The Post Office Department, in inviting bids for equipment and supplies, uses the United States Government master specifications promulgated by the Federal Specifications Board in practically 90 per cent of its purchases.

The specifications covering furniture and screen-line equipment for use in leased buildings occupied as post offices are drawn up by a committee of experts of the department, who confer with the leading manufacturers of post-office equipment throughout the United States. These standard specifications are used in the procurement of furniture by the department as well as the lessors of buildings.

Practical men of the department draw up specifications for conveyers, mail truck bodies, letter boxes of various types, letter carriers' satchels, both leather and canvas, and other labor-saving devices.

Approximately $16,500,000 was expended by the department for equipment and supplies during the fiscal year ended June 30, 1926. Every effort was made to perfect the methods in procuring such equipment along the lines of economy.

The substitution of 1-ply jute twine with the same yardage and strength as the 2-ply jute twine that was used in the Postal Service for many years brought about keen competition that resulted in a savings to the department during the last fiscal year of $53,800.

The substitution of newsprint paper for manila paper used for facing slips resulted in a saving of $11,776.20.

The specifications promulgated by the Federal Specifications Board result in satisfactory business relations between the department and manufacturers and dealers, as it places all bidders on an equal basis.

Standardization of Official Envelopes.—The law (act of January 12, 1895, sec. 96, 28 Stat. L. 624; as amended by the act of June 26, 1906, 34 Stat. L. 476) requires the Postmaster General to contract for all envelopes for use by all departments, bureaus, establishments, and services of the Government. Under a recent provision of law certain plain envelopes for use in the District of Columbia are supplied by the Public Printer.

Prior to expiration of the annual contract term a representative selected by each department and establishment is appointed by the Postmaster General to serve on a committee in preparing specifications for official envelopes under new contracts for the ensuing term. The members of this committee are well versed in the needs of their respective offices for official envelopes, and in a series of meetings, at which the representative of the Post Office Department acts as chairman, they determine what sizes, styles, qualities, and colors of envelopes will be needed, and prepare the schedule for the use of the manufacturers and dealers in submitting their bids responsive to the notice published by the Postmaster General inviting bids.

The preparation of these specifications as embodied in the schedule is the only function of this interdepartmental committee, but an important result of this procedure is the elimination of those items which are no longer needed and the consolidation of the envelope requirements into a fewer number of sizes and grades. Persistent effort has been made in recent years to eliminate from the schedule all sizes which are not regular commercial sizes and all unusual grades or qualities of paper. A number of special sizes of envelopes have been required to cover inclosures of special sizes or shapes already in stock and in regular use by some of the departments. Some of the unusual sizes are for filing purposes and not for transmission in the mails, and a few items are needed to provide for variations in the position of the "window" in window envelopes.

The aggregate quantity of these envelopes needed for the current fiscal year is estimated at 230,000,000. The current schedule includes 69 different sizes, covering 114 items, not including 2 expansion items.

The efforts of the department at standardization in this subject have resulted in reducing the number of items in the schedule from 306 in the fiscal year 1920 to 116 in the schedule for the current year.

TREASURY DEPARTMENT

BUREAU OF THE PUBLIC HEALTH SERVICE

Members of the bureau represent the Treasury Department on 15 technical committees of the Federal Specifications Board.

The Bureau of the Public Health Service is represented on the American Engineering Standards Committee sectional committee for the development of the industrial sanitary code and is sponsor for the project. This involved the review of sanitary codes in use in the United States, England, Germany, Belgium, and Holland. The best parts of these codes were taken and compiled into one general code. The code was then submitted to labor departments of various States, the American Federation of Labor, various Government departments, universities, industrial physicians, and industries, for their review and comment.

The bureau is also represented on eight additional sectional committees functioning under American Engineering Standards Committee procedure.

At the request of the American Red Cross, standardization of the technique of the prone pressure method (resuscitation) was undertaken. A review of the methods used was first made, and a tentative plan submitted to various industries, organizations, and labor bodies interested. Comments upon the tentative plans were then considered and a second plan submitted. A conference was then called of a few of the organizations still at variance, and the final draft completed. The wording for the standard method of prone pressure resuscitation has been accepted by the American Gas Association, National Electric Light Association, United States Bureau of Mines, Industrial Physicians and Surgeons, Bethlehem Steel Corporation, National Bureau of Standards, American Red Cross, National Safety Council, American Medical Association, American Telephone & Telegraph Co., United States Army, United States Navy, and the United States Public Health Service.

Hygienic Laboratory.—Official standards and standard tests include diphtheria antitoxin, tetanus antitoxin, typhoid vaccine, botulinus antitoxin, perfringens antitoxin (gas gangrene) arsphenamine, scarlet fever streptococcus toxin, antimeningococcic serum, antipneumococcic serum, antidysenteric serum, diphtheria toxin-antitoxin mixture,

diphtheria toxin for Schick test, and diphtheria toxoid. Work is being done on the standardization of digitalis, pituitary extract, and insulin.

Accomplishments for 1926.—Aside from control work connected with the Biologics law, progress is being made in the following researches: Tularæmia, filterable viruses, vaccination sequelæ, typhus, studies in pathology, medical zoology, oxidation reduction processes, malignant tumors, pneumonia, trachoma, nutrition, tuberculosis, and Rocky Mountain spotted fever.

BUREAU OF SUPPLY

A member of the Bureau of Supply represents the Treasury Department on the technical committee on office supplies, Federal Specifications Board.

DIVISION OF CUSTOMS

A member of the division of customs represents the Treasury Department on the technical committee on commercial weighing and measuring devices, Federal Specifications Board.

GENERAL SUPPLY COMMITTEE

The General Supply Committee was created by section 4 of the act of June 17, 1910 (36 Stat. 531), in lieu of the Board of Awards provided for in section 3709 of the Revised Statutes, as amended, and is composed of officers, one from each of the executive departments, designated by the head thereof. The superintendent of supplies, who is appointed by the Secretary of the Treasury, is ex officio secretary of the General Supply Committee, and he conducts all correspondence, supervises the preparation of all contracts, and performs such other duties as the Secretary of the Treasury may direct. It is the duty of the General Supply Committee to make an annual schedule of required miscellaneous supplies for the use of each of the executive departments and other Government establishments in Washington, to standardize such supplies, eliminating all unnecessary grades and varieties, and to solicit bids based upon formulas and specifications drawn up by such experts in the service of the Government as the committee may see fit to call upon, who shall render whatever assistance it may require, provided that the articles intended to be purchased in this manner shall be those in common use by or suitable to the ordinary needs of two or more such departments or establishments. United States Government master specifications are used where they are applicable. Every purchase or drawing of such supplies from the contractor is immediately reported to said committee. No disbursing officer may be a member of the committee.

By the Executive order of December 3, 1918, and Treasury Department Regulations, dated December 10, 1918, the General Supply Committee has direct charge of the transfer and sale of surplus office material, supplies, and equipment in the hands of the executive departments and other establishments of the Government in the District of Columbia, and is required to keep a record of all material received and disposed of by it.

The Executive order of August 27, 1919, carrying into effect the provisions of the act of July 11, 1919, designates the General Supply Committee as the central agency to maintain records of all material, supplies, and equipment available throughout the United States because of the cessation of war activities. To the committee are directed all inquiries from the various governmental establishments regarding the availability of such surplus supplies and equipment.

The superintendent of supplies, General Supply Committee, represents that activity on the executive committee of the Federal Specifications Board.

The General Supply Committee is represented on 36 technical committees of the Federal Specifications Board.

The General Supply Committee is an interdepartmental organization which, under the direction of the Secretary of the Treasury, functions as a contracting agency in behalf of all the executive departments and independent establishments of the Government in the District of Columbia.

On instructions from the Chief Coordinator, the committee has, with respect to many commonly used items, embarked upon a policy of procurement in definite quantities rather than making annual contracts for furnishing articles in indefinite quantities from time to time. Requirements for these items are assembled four times a year, proposals therefor are solicited for immediate delivery and a single shipping direction placed for the entire quantity needed at one time. Upon the delivery of the supplies, a single inspection is made of each item prior to distribution to the various using services. This policy has eliminated overhead costs to both the Government and the contractor and has resulted in decidedly lower prices in many lines with a resulting saving to the Government of hundreds of thousands of dollars.

OFFICE OF THE DIRECTOR OF THE MINT

The Director of the Mint represents the Treasury Department on the technical committee on refractories of the Federal Specifications Board.

The assayer of the laboratory, Bureau of the Mint, tests gold and silver coins to determine whether they are within the legal requirements as to weight and fineness. The coinage laws provide for

variations in the fineness of individual coins of one one-thousandth for gold and three one-thousandths for silver.

The Revised Statutes, section 3547, provide for an annual test of the domestic coinage executed during the prior year. The purpose is "to secure a due conformity in the gold and silver coins to their respective standards of fineness and weight."

The coins are directly weighed against a set of sealed coin weights, which are accompanied by a certificate signed by the Director of the Bureau of Standards, and which gives the value of the weights in terms of the United States standard. The weighings are made on a balance supplied by the Philadelphia Mint, which is tested as to its equality of arms and as to sensibility.

The Director of the Mint publishes quarterly an estimate of the value of the standard coins of foreign countries for customhouse and other public purposes.

SUPERVISING ARCHITECT

The superintendent, computing division, of the Supervising Architect's Office, represents the Treasury Department on the Executive Committee of the Federal Specifications Board.

Members of the Supervising Architect's Office represent the Treasury Department on 29 technical committees of the Federal Specifications Board.

The Supervising Architect's Office is represented on seven sectional committees of the American Engineering Standards Committee.

The Office of the Supervising Architect has jurisdiction over the preparation of plans and specifications for, and the construction, remodeling, maintenance, and repair of, Federal buildings under control of the Treasury Department, including approximately 1,400 post offices, customhouses, courthouses, marine hospitals, quarantine stations, etc. It also not infrequently performs architectural and construction work for other departments.

The work of the office toward the standardization of its plans and specifications has been along the following lines: The work of adopting standard types of design for post-office buildings was initiated about 15 years ago, when a large number of post-office buildings of similar type, based upon one standard design, were constructed. Since that time 15 or more standard designs have been developed and are being employed whenever practicable. These designs are prepared by the architectural division, and are modified to the extent necessary after conference with officials of the Post Office Department to meet the varying requirements as to size of working space, character of service connections, and topography of sites. It is, of course, impracticable to standardize the design of large buildings of monumental type, to be occupied by a number of different governmental

activities; the work of standardizing the types of the smaller buildings will, however, be carried as far as may be found practicable. In addition to this, hundreds of details of construction, equipment, etc., have been embodied in standard miscellaneous drawings which are used wherever applicable.

United States Government master specifications for materials are used for the construction and equipment of Federal buildings.

In 1918, the office prepared for its own use standard specifications covering all branches of construction work in buildings under its supervision. These have been modified by changing conditions and by the increasing use of the Federal Specifications Board's specifications, but are still in use as far as they are applicable. During the past year standard specifications for heating materials, electrical materials, gas piping, and lighting fixtures have been formulated and adopted for use in connection with the mechanical equipment of buildings.

There can, of course, be no rigid standardization of specifications for workmanship, due to architectural requirements in the treatment of materials, the constant adoption of new methods, etc., but these specifications have nevertheless been made fairly uniform through long experience and practice.

The standardization of furniture and supplies for public buildings was practically completed by the maintenance division of the office about five years ago. The furniture for use in post-office workrooms has been standardized, the types for each building being determined by a committee composed of representatives of the Supervising Architect's Office and of the Post Office Department. The types of furniture for general office use have been reduced to about half the number used in commercial practice. Desks and file cases are standardized as far as the requirements of the service will permit. The office specifications for furniture are being used by the office furniture technical committee of the Federal Spedifications Board in the development of United States Government master specifications.

With the use of standard building designs, standard specifications for materials not yet covered by Government master specifications, and the United States Government master specifications for materials promulgated by the Federal Specifications Board, this office is well advanced toward standardization to the extent that its functions permit.

UNITED STATES COAST GUARD

Members of the Coast Guard represent the Treasury Department on six technical committees of the Federal Specifications Board:

The Coast Guard is represented on two sectional committees of the American Engineering Standards Committee.

The United States Coast Guard makes every effort in the construction, maintenance, and repair of its vessels and stations, to standardize machinery and other eqiupment, and the requirements of the service are constantly studied with this end in view. In compiling specifications for new construction and repairs, the aim has been to eliminate requirements for special materials, and to adopt fittings which have been standardized in the commercial field, and the specifications promulgated by the Federal Specifications Board are used where applicable.

WAR DEPARTMENT

The following standardization regulations of the War Department, have been extracted from Army Regulations No. 850–25, dated December 24, 1924, with amendments, and supplemented by explanatory remarks:

(*a*) The War Department representative on the Federal Specifications Board is the chief, equipment branch, supply division, General Staff.

(*b*) Procedure for adoption of United States Government master specifications by the War Department. After the master specifications are promulgated by the Federal Specifications Board, the War Department representative is furnished copies which are transmitted by him to the War Department branch concerned where they are republished as United States Army specifications, all technical requirements conforming to the master specification. The Adjutant General's office publishes from time to time orders showing the numbers and subjects of all United States Government specifications, for the information of the service only.

(*c*) The following supply branches of the Army have members representing the War Department on the number of technical committees of the Federal Specifications Board indicated:

Quartermaster Corps, 40.
Medical Corps, 7.
Corps of Engineers, 9.
Ordnance Department, 4.
Signal Corps, 5.
Chemical Warfare Service, 2.
Air Corps, 3.

(*d*) United States Government specifications promulgated by the Federal Specifications Board are master specifications, and are not intended to be used directly for procurement by the War Department. They form the basis of specifications prepared by the War Department, and it is mandatory that each specification so prepared be prefaced with the statement that its technical requirements conform in detail to the United States Government specification for the

36316—27——8

commodity, as approved by the Federal Specifications Board, giving the number of the master specification applying. (Bulletin No. 24, Supplement No. 1, Office of the Chief Coordinator, February 3, 1924.)

(*e*) Specifications covering items which are of a strictly military and confidential nature are not considered by the Federal Specifications Board.

American Engineering Standards Committee.—(*a*) The War Department is a member body of and has three representatives and three alternates on the American Engineering Standards Committee. This representation is divided as follows:

One from equipment branch, G–4, supply division.
Two from the supply branches.

In addition, supply branches not represented on the committee are given alternates in order to keep in close touch with the activities of the committee.

(*b*) The War Department, as such, is represented on seven sectional committees of the American Engineering Standards Committee.

(*c*) Various supply branches of the War Department are represented on sectional committees of the American Engineering Standards Committee, as follows:

Quartermaster Corps, 2.
Corps of Engineers, 2.
Ordnance Department, 3.
Air Corps, 1.

National Screw Thread Commission.—Two members of the Ordnance Department represent the War Department on the National Screw Thread Commission.

The War Department is represented (Watertown Arsenal), with other activities, on the joint committee on investigation of the effect of phosphorus and sulphur in steel.

Joint Army and Navy Board for Coordinating and Standardizing Specifications.—Types, grades, or classes of materials approved by joint Army and Navy boards for coordinating and standardizing specifications will be incorporated in equivalent United States Army specifications.

PRESENT STATUS OF WAR DEPARTMENT STANDARDIZATION AND RESULTS ACCOMPLISHED DURING 1926

1. The Quartermaster Corps issued 146 new or revised specifications during 1926.

2. (*a*) The Medical Department of the War Department is working in conjunction with the Bureau of Medicine and Surgery of the Navy Department in attempting to make the supply lists of the two departments conform so far as can be done in view of the different functions of those departments.

(*b*) Attempt has been made to arrive at an agreement with the drug industry with regard to a standardization of their shipping problem in the preparation of specifications covering drugs and pharmaceuticals. At the instigation of the Surgeon General, United States Army, the American Drug Manufacturers Association at its last annual meeting, appointed a committee which is now endeavoring to draft specifications covering shipping containers for drugs and pharmaceuticals. It is believed that this work will not only be of material advantage to Government departments but may also result in standardization of commercial practice. During 1926, 21 specifications covering 476 articles have been approved or revised.

3. (*a*) The Corps of Engineers standardization activities cover certain commodities entering into the construction of bridges, locks and dams, revetments, and fortification work, railway equipment, and other items used for military purposes.

(*b*) The Board of Engineer Equipment, consisting of officers of the Corps of Engineers, appointed by the Chief of Engineers, designs and develops equipment for military purposes, which is finally adopted as standard for the United States Army. During 1926, 26 specifications were approved and adopted as standard.

4. (*a*) The Ordnance Department is in full sympathy with the work of the division of simplified practice, Department of Commerce, and very willingly adopts every possible reduction in size or variety included in its recommendations.

(*b*) The technical staff of the Ordnance Department approves all designs and drawings of ordnance material, and in giving such approval effort is made to see that design practice conforms to the most generally used commerical standards. During 1926, 68 standard specifications have been approved.

5. The Signal Corps represents the War Department on the standardization communication committee of the Army and Navy Munitions Board, the functions of which are to investigate:

(*a*) Standardization of interchangeable parts of communication units.

(*b*) The possibility of using the same identification units now carrying one designation in the Army and another in the Navy. During 1926, 26 new specifications and 48 revised specifications have been approved.

6. The Chemical Warfare Service policy governing the preparation and printing of specifications is typical of that followed in the other supply branches, though differing in minor details.

7. (*a*) The Air Corps holds a meeting once a year with representatives of the Bureau of Aeronautics of the Navy Department and the aircraft industry, where specifications for materials, equipment, and parts considered suitable for general use are discussed and agreed

upon if possible. In addition, there are meetings from time to time to discuss individual items or groups of items.

(*b*) During the year 1926 steps were taken to revise and distribute the Air Corps Standards Book to include the standards decided upon at the 1925 meeting with representatives of the Bureau of Aeronautics, Navy Department, and the aircraft industry. This included agreement on 19 classifications of miscellaneous parts and 14 classifications of strictly aeronautical parts. At the 1926 meeting tentative agreement was reached on classifications of standard parts. Several specifications covering materials have also been agreed upon between representatives of the Army and the Navy for aircraft use and 15 additional are under discussion. See page 80, Navy Department, Bureau of Aeronautics, for details.

INDEPENDENT ESTABLISHMENTS

BOARD OF SURVEYS AND MAPS OF THE FEDERAL GOVERNMENT

The Board of Surveys and Maps of the Federal Government was created by Executive order dated December 30, 1919, to coordinate the activities of the various map-making agencies of the executive departments of the Government, to standardize results, and to avoid unnessary duplication of work.

The following organizations were included in the Executive order:

Corps of Engineers, United States Army.
United States Coast and Geodetic Survey, Department of Commerce.
United States Geological Survey, Department of the Interior.
General Land Office, Department of the Interior.
Topography branch, Post Office Department.
Bureau of Soils, Department of Agriculture.
United States Reclamation Service, Department of the Interior.
Bureau of Public Roads, Department of Agriculture.
Bureau of Indian Affairs, Department of the Interior.
Mississippi River Commission, War Department.
United States Lake Survey, War Department.
International (Canadian) Boundary Commission.
Forest Service, Department of Agriculture.
United States Hydrographic Office, Navy Department.

Amendatory Executive orders of March 17, 1920, and January 27, 1921, named as additional organizations, for membership on the board:

Military Intelligence Division, General Staff, War Department.
Federal Power Commission.
Air Corps, United States Army.
Bureau of Aeronautics, Navy Department.

At a special public meeting of the board, held July 12, 1920, representatives of 22 non-Federal organizations were named to constitute an advisory council to the board. The organizations

represented on the advisory council as originally constituted were the following: American Association of State Highway Officials, American Automobile Association, American Forestry Association, American Geographical Society, American Institute of Electrical Engineers, American Institute of Mining and Metallurgical Engineers, American Railway Engineering Association, American Society of Agricultural Engineers, American Society of Civil Engineers, American Society of Mechanical Engineers, American Water Works Association, Appalachian Mountain Club, Association of American Geographers, Association of State Geologists, Federated American Engineering Societies, Geological Society of America, National Electric Light Association, National Research Council, Rocky Mountain Club, Sierra Club, Society of Automotive Engineers, and Map Publishers.

One additional organization—the Society of American Military Engineers—was added January 8, 1924.

The advisory council to the board was organized to carry out the provisions of the Executive order of December 30, 1919, touching the relations of the board with the public. The organizations represented by the members of the advisory council include probably more than a half million map users, who employ maps for themselves and their clients to the number of several millions of the citizens of the United States. At each public meeting members of the advisory council are present, take part in the discussions, and make recommendations concerning mapping problems.

The original Executive order creating the Board of Surveys and Maps called for the establishment of a central information office, to be located in the United States Geological Survey, to act as a clearing house for map information. The work of the map information office was started in January, 1920, under the direction of a topographic engineer assigned from the United States Geological Survey. The office is in touch with Government map-making bureaus and also with commercial firms and individuals publishing maps in this country and abroad. It is also well supplied with lists and catalogues pertaining to published maps. The collection of such data in one office assures prompt answers to requests for information, and the increasing use of its facilities is evidence of its value as an economic feature of governmental work.

The board has considered and adopted many reports containing recommendations for the use and guidance of map makers. Outstanding among the subjects dealt with in such reports are the use of aerial photographs in topographic mapping; specifications for horizontal and vertical control; standard forms of monuments; scale of standard topographic maps; standard projections for base map of the United States, base map of a single State, and topographic map

of a quadrangle; standards for base maps of the United States, Territories, and possessions; standard scales for base maps of States; and standard map symbols.

The greatest benefit resulting from the activities of the board is the close and harmonious cooperation brought about between the various Government bureaus. Data regarding completed or projected work are systematically collected by the map information office and given to bureaus interested, and in some cases to foreign governments.

BUREAU OF THE BUDGET

The Bureau of the Budget was created by the act approved June 10, 1921. It is under the immediate direction of the President. Under rules and regulations prescribed by the President, the bureau prepares for him the annual budget and such supplemental or deficiency estimates as the President may recommend from time to time to Congress. To this end the bureau has the authority, under the act, "to assemble, correlate, revise, reduce, or increase the estimates of the several departments and establishments." The act requires the head of each department and establishment to appoint a budget officer whose duty it is to prepare, under his direction, the departmental estimates of appropriations and such supplemental or deficiency estimates as may be required. These officials are liaison officers between the department and the Bureau of the Budget. The bureau deals directly with them in the routine work of preparing the budget. The estimates are prepared and submitted to the bureau in such form, manner, and detail as the President prescribes. On or before September 15 of each year the head of each department and establishment revises his estimates and submits them to the bureau.

OFFICE OF THE CHIEF COORDINATOR

The Office of Chief Coordinator was created by Circular No. 15, Bureau of the Budget, July 27, 1921, and the duties of the office were later enlarged by the following Budget circulars, Nos. 22, 23, 25, 26, 35, 41, 42, 47, 52, 54, and Executive order No. 3578, dated the White House, November 8, 1921.

Subject to general supervision by the Director of the Bureau of the Budget, the Chief Coordinator handles all questions of coordination arising through the application of the policies of the President and of the Congress to the routine business activities of the executive branch of the Government.

The preparation of a catalogue of Federal property at large (Federal stock catalogue), by the Office of the Chief Coordinator, elaborating the following 25 categories of supplies previously established by

that office (Bulletin No. 43, 2d ed., Office of Chief Coordinator, July 30, 1925), is well under way, and it will shortly be ready for publication.

CATEGORIES

Aeronautic Apparatus.—Automotive accessories.

Books.—Blank forms, blue prints, charts, drawings, maps, music, newspapers periodicals, etc.

Building Material.—Asphalt, brick, cement, granite, gravel, lime, millwork, roofing material, sand, stone, tar, tiling, etc.

Chemicals, Lubricants, Paints.—Acids, cleaning compounds, cutting compounds, greases, oils, polishing compounds, soaps, etc.

Clothing (equipage).—Accouterments, athletic apparel, badges, boots, buttons, caps, findings, hats, insignia, medals, men's furnishings, shoes, sporting goods, trimmings, women's clothing, etc.

Cordage.—Cotton line, hawsers, hemp, oakum, rigging, rope, sash cord, signal halliard, twine, wire, bare wire cable, wire rope, yarns, etc.

Electrical Supplies (radio supplies).—Cable, insulated, sound-signal supplies, telegraph outfits, telephones, wire, insulated, etc.

Foodstuffs.—Canteen supplies, forage, groceries, ice, provender, provisions, refrigerator supplies, sea foods, ship's store supplies, subsistence supplies, toilet articles, etc.

Fuel.—Charcoal, coal, coke, dust fuels, fuel oil, gas, gasoline, wood, etc.

Furniture (office equipment).—Adding machines, cash registers, clocks, file cases, numbering machines, safes, typewriters, etc.

Hardware (builders', general, marine).—Agricultural implements, anchors, blocks, boat fittings, bolts, brooms, brushes, chain, engine fittings, fireroom fittings, nuts, rivets, ship fittings, washers, etc.

Household and Kitchen Utensils (boat and ship utensils).—Chinaware, cushions, floor coverings (nontextile), furnaces, galley apparatus, glassware, hotel ware, lighting apparatus (nonelectric), linoleum, mattresses, pictures. pillows, ranges, silverware, stoves, etc.

With the completion of this compilation there will be available to the supply units of the Government for the first time a master key or index to existing supply terminology covering articles in common use by two or more departments. This will not necessitate the discarding of systems in use by those establishments which have such catalogues particularly designed for their own services, but it will enable purchasing officers through the use of this master key intelligently to discuss and agree upon cooperative plans of procurement whenever conditions for such action are favorable and will, it is believed, prove of great assistance in the coordination of purchases throughout the Government.

The Federal coordinating boards and agencies form an integral part of the Federal budget system, and they are under the supervision of the Chief Coordinator.

COORDINATOR FOR PURCHASE

The office of coordinator for purchase was established by Circular No. 160, Bureau of the Budget, May 29, 1925, by direction of the President, "* * * to act as agent through whom the Federal Purchasing Board, acting for and in behalf of the separate purchasing agencies of the Government, may, with the approval of the Chief Coordinator, effect such joint procurement arrangements as may be agreed upon. He will personally, or through some department or establishment advantageously situated, issue single proposals inviting bids on individual commodities or natural groups thereof, for the combined requirements of two or more departments or establishments, as recommended after study by the Federal Purchasing Board. He will also perform such additional duties in the clearance and distribution of procurement information and operations incident thereto as may be properly delegated to him by the Chief Coordinator."

Some 10 investigations have been conducted with respect to many commodities for the purpose of determining the most advantageous method of purchasing the requirements of the entire Federal Government, and recommendations are either now under consideration or have been given effect. More often than otherwise these investigations were prompted by suggestions from representatives of departments desirous of effecting greater economy in, or facilitating, procurement.

Chief among these investigations has been the study which was begun on the procurement of bituminous coal. So far the requirements of two activities have been analyzed, with the result that their combined requirements for the coming fiscal year have been handled by two single purchases, which in the past have been filled from two distinct coal-production areas.

This line of development is progressing with a view ultimately of grouping into single combined purchases the entire annual requirements of all activities which can be logically considered as attractive to the trade in the separate coal-production areas.

There has been compiled, probably for the first time, an inventory of all the motor vehicles owned by the Federal Government. This exhibit has proved of value to several departments as an aid in their work, and by its reflection of exceptionally numerous trade names or makes has further indicated the desirability of simplifying the means of purchase. Consideration is being given to inaugurating an annual inventory of such equipment, not only as a record of property but also as evidence of the transportation facilities available within the Government.

A record is being set up to aid the various purchasing officers in the determination of the advisability of discontinuing relations with

vendors who show a tendency toward or who have indulged in unscrupulous or fraudulent practices.

The coordinator is at present engaged in preparing an analysis or digest of the respective proposals used by the various departments and establishments in the purchase of bituminous coal with a view to ultimately developing a uniform method in lieu of numerous and diverse methods now employed. This office is also accumulating information pertaining to automobile pneumatic tires and tubes which have failed to give satisfactory service and which have not been examined to determine whether they individually met the specifications, with a view to obtaining some idea as to whether existing specifications actually provide for tires and tubes which should give satisfactory service under the various operating conditions to be encountered throughout the country.

FEDERAL PURCHASING BOARD

The Federal Purchasing Board was created by Executive order promulgated in Bureau of the Budget Circular No. 25, of August 25, 1921. The board is composed of one representative from each department and independent establishment having authority to purchase supplies, together with a representative from the Federal Specifications Board, for maintaining liaison between the two boards.

The membership of the board is as follows:

Commander R. H. Johnston (S. C.), United States Navy, executive chairman.
- Department of Agriculture, A. McC. Ashley.
- Department of Commerce, W. S. Erwin.
- Department of the Interior, Walter B. Fry.
- Department of Justice, Harry C. Maull, jr.
- Department of Labor, Shelby Smith.
- Navy Department, Capt. F. G. Pyne (S. C.), United States Navy.
- United States Marine Corps, Maj. John Potts.
- Post Office Department, T. L. Degnan.
- Department of State, H. C. Hengstler.
- Treasury Department, D. C. Vaughan.
- War Department, Lieut. Col. E. D. Peek, United States Army.
- District of Columbia, M. C. Hargrove.
- General Supply Committee, Robert LeFevre.
- Government Printing Office, E. E. Emerson.
- Panama Canal, A. L. Flint.
- Federal Specifications Board, N. F. Harriman.
- United States Shipping Board, G. F. Williams.
- United States Veterans' Bureau, R. C. Kidd.

The board formulates policies and plans to unite purchasing activities of the several departments and establishments and to bring about business methods calculated effectively to safeguard the interests of the Government and at the same time promote the confidence of private business interests having dealings with the Govern-

ment. It studies purchase operations with a view to determining the advisability of centralizing purchases within departments, coördination among departments, utilization of surplus, and economies to be effected by combined purchases. Detailed studies are made of the requirements of the Government as a whole both as to quantities and qualities, available sources, localities, seasons of supply, means of transportation and storage, and kindred conditions involving purchases.

Efficient procurement requires uniform application of approved methods of purchase and procurement activities. The Federal Purchasing Board serves to coordinate the purchasing machinery of the Government and to work out and standardize practical business methods pertaining to Federal purchases to keep them in harmony with industry.

Attention is directed toward the functions of purchase rather than toward the properties of materials or the desirability or necessity for the use of the articles. Through the agency of this board intradepartmental purchasing is more closely supervised and centralized than formerly, and interdepartmental coordination is more easily effected. Suggestions from industry or from the services themselves are welcomed, encouraged, and considered to a conclusion and recommendation. The board has presented to the Federal Specifications Board the need for master specifications on several items, has suggested revision of some in use, and has been greatly benefited by the many standardized specifications already promulgated.

The board has transmitted to the Interdepartmental Board of Contracts and Adjustments operating experience pertaining to contracts, bid bonds, performance bonds, discounts, penalties, and liquidated damages. It is the sense of this board that since the basis of a contract is a meeting of minds and the existence of reciprocal good faith, a liquidated-damage clause is undesirable.

With the assistance of the Federal Traffic Board in furnishing transportation rates, the board has recommended that bids be invited both f. o. b. point of manufacture and f. o. b. point of delivery, in order that awards to the best interest of the Government might be made. Acceptance of bids f. o. b. point of production permits transportation on Government bills of lading at land grant or special Federal rates.

It has recognized the valuable progress made by the division of simplified practice, Department of Commerce, and is committed to the purchase of standardized lines whenever practicable.

It has supported the investigations and studies of the Interdepartmental Board on Simplified Office Procedure in the reduction in number and in the preparation of standardized forms for various

purposes, in the reduction in number and kinds of envelopes for official use, and is committed to these recommendations.

The right of purchase against a contractor's account is exercised with justice, but sparingly. Delinquencies are investigated and no debarment is made except for cause. Debarment from bidding is not done for the purpose of punishing a dealer, but as a protection to the Federal services. In order to insure that purchasing agents may know the character of unsatisfactory bidders debarred for reason, notices are now exchanged between purchasing offices. Debarment by one department for fraud or attempted fraud against the Government is followed by the same action throughout the services.

In term contracts the speculative element has great bearing, and the board favors them only for those supplies which are not subject to fluctuation in price. The number of items purchased under such contracts is diminishing.

In definite-quantity purchases, with delivery at a stated time, this function is eliminated, prices are lower, and quality better. The board approves of this method within the departments and advocates that the market should be entered at seasonable times to purchase those commodities which do fluctuate in price.

Continuous attention and encouragement has been given to the consolidation of the requirements of several items for all departments for a given short period and to making a consolidated definite quantity Federal purchase of the whole amount. This method heretofore efficiently developed in the purchase of tires and tubes has been extended to the purchase of gasoline, coal, lubricating oils, surgical supplies and instruments, and with the experience gained will be applied to other commodities in common use. The board has recommended the creation of an operating fund with which to finance these purchases, the fund to be reimbursed directly from appropriations of departments receiving these supplies. A bill to provide this fund is before the House of Representatives.

The board has discussed the coordination of inspection in order that a single inspection by any one of the departments participating in a consolidated purchase may serve for all. This will reduce the cost of inspection, save time, permit earlier payment, and allow the largest savings in discounts.

FEDERAL SPECIFICATIONS BOARD

The Federal Specifications Board was organized under authority of Circular No. 42, Bureau of the Budget, dated October 10, 1921, in which it is stated that the establishment of the board is " * * * for the purpose of coordination and economy in the procurement of materials and services used by the Government under specifications prepared by the various branches thereof, to avoid duplication of

effort, and for the better utilization of resources and industries." The duties of the Federal Specifications Board are to compile or adopt and promulgate, standard specifications for materials and services and to bring the Government specifications into harmony with the best commercial practice wherever conditions permit, bearing in mind the desirability of broadening the field of supply.

Each department and establishment purchasing materials and supplies in accordance with specifications designated a representative to serve as a member of the board. The initial meeting was held on October 31, 1921, at which time an executive committee, consisting of the representatives from the 10 executive departments, the Panama Canal, and the General Supply Committee, was formed as being more compact for the routine handling of the business of the board.

The personnel of the Federal Specifications Board is as follows, the members of the executive committee being indicated with an asterisk (*):

*Dr. George K. Burgess, Director, Bureau of Standards, chairman.
*N. F. Harriman, senior engineer-physicist, Bureau of Standards, vice chairman and technical secretary.
*A. McC. Ashley, chief, division of purchase, sales, and traffic, Department of Agriculture.
*Capt. E. L. Bennett, Assistant Chief, Bureau of Engineering, Navy Department.
John F. Bethune, secretary, United States Tariff Commission.
*Dr. William A. Bevard, first aide, Department of Labor.
*C. A. Bissell, engineer, Bureau of Reclamation, Department of the Interior.
*J. S. Conway, deputy commissioner, Bureau of Lighthouses, Department of Commerce.
*W. A. E. Doying, inspecting engineer, the Panama Canal.
*J. W. Ginder, superintendent, computing division, Supervising Architect's Office, Treasury Department.
T. L. Haden, chief clerk, Interstate Commerce Commission.
A. J. Harrison, assistant chief, purchase and issue subdivision, supply division, United States Veterans Bureau.
*H. C. Hengstler, chief, Division of Foreign Service Administration, State Department.
*George Landick, jr., superintendent, Division of Equipment and Supplies, Post Office Department.
*Robert LeFevre, superintendent of supplies, General Supply Committee.
*H. C. Maull, jr., chief clerk's office, Department of Justice.
*Lieut. Col. J. E. Munroe, chief, equipment branch, supply division, General Staff, War Department.
Maj. John Potts, assistant quartermaster, United States Marine Corps.
Edward O. Reed, chief of tests, Government Printing Office.
*George M. Talbot, assistant director of supplies, Emergency Fleet Corporation, United States Shipping Board; alternate, G. F. Williams.
J. W. Wimer, deputy purchasing officer, commissioners, District of Columbia.
R. L. Woodward, assistant purchasing agent, United States Civil Service Commission.

The procedure adopted for the consideration of specifications is as follows: The need of specifications for a given article or material, for either technical or business reasons, is fully considered by the executive committee, and the subject is then referred to a technical committee composed of the Government experts in the particular subject, for consideration of all existing Government or commercial specifications. A specification is selected, or written, which will be suitable for the uses of all departments and establishments of the Government. The cooperation and advice of interested commercial and industrial concerns is requested and their recommendations are fully considered by the technical committees. The specification as agreed on by the technical committee is then submitted to all departments and establishments of the Government, through their respective representatives on the Federal Specifications Board, for comment and criticism. At the same time, copies of the proposed specifications are informally submitted to the American Engineering Standards Committee with a request for their assistance in securing comment and criticism from the various interested engineering and technical societies of the country. All criticisms received are referred back to the respective technical committees for consideration on their merits. When the specification is finally agreed upon, it is promulgated by the Federal Specifications Board as official Government standard for use in connection with the purchase of material covered by the specification.

As far as practicable the specifications of the board are arranged in accordance with a standard form originally adopted in 1924 and revised in 1925.

Standard specifications are divided into eight sections, as follows:

I. General Specifications.—In this section reference is made to any applicable general specification and drawings forming a part of the specification, with a statement that such general specification and drawings form a part of the specification. This section serves as an index to the documents which must be considered to permit a complete interpretation of the specification.

II. Types, Grades, Classes, etc. (as applicable).—In this section are listed the several types, grades, classes, etc., of articles or materials covered by the specification, preceded by the words: "* * * shall be of the following types (grades, classes, etc.)." If only one type, grade, class, etc., is required, it is so stated. The types, grades, classes, etc. (if more than one), are listed under a brief name convenient for reference and in accordance with commercial practice, and whenever practicable are designated by capital letters or Arabic numerals. The same designations are used under "Detail requirements," Section V, and under "Methods of inspection, tests, etc.,"

Section VI, if applicable, so that Section II will serve as an index to the subject matter of the specification.

III. Material and Workmanship, etc.—Under this heading are included any necessary requirements relative to the character or quality of the materials used, the method of manufacture, and workmanship. Any requirements with reference to the use of scrap are here stated.

IV. General Requirements.—All essential requirements and descriptions which are applicable to the articles or materials and which are common to all of the types, grades, classes, etc., covered by the specifications are stated in this section. Tolerances permitted, if common to all types, grades, classes, etc., are included. If spare parts are required for all types, grades, classes, etc., they are listed here.

V. Detail Requirements.—In this section the items listed in Section II, "Types, grades, classes, etc.," are considered consecutively, when practicable, using the name and designation in full, detailing for each such physical and chemical requirements, characteristics, and descriptions as may be necessary to define clearly the articles or materials required. Where only one type, grade, or class, etc., is provided, care is exercised to place detail requirements under this section rather than under Section IV. The following, when applicable, are included, the statements under each heading being contained in a separate subparagraph, properly designated: Physical requirements; chemical requirements; treatment; finish; plans; tolerances; spare parts not listed in Section IV.

VI. Method of Inspection, Tests, etc.—In this section are stated the tests to which the articles or materials are to be subjected in order to determine whether they conform to the requirements of the specification. This section also includes such descriptions of tests and methods of analysis as may be necessary to insure that they will be properly conducted, and other information, such as location of test specimens, method of sampling for chemical analysis, etc.

When an umpire method of analysis is specified, either in the form of a detailed description or by reference to some accepted standard method, it is placed at the end of this section and plainly captioned "Umpire method of analysis."

VII. Packing and Marking.—Ordinarily instructions regarding packing and marking do not form a part of the master specifications promulgated by the Federal Specifications Board. However, instances arise where marking for identification, or certification, and special methods of packing to insure against damage in shipment, etc., should properly be included. Where packing or marking, or both, are included in the specification detailed instructions therefor appear in this section.

VIII. **Notes.**—This section, which is restricted to informative matter only, contains all necessary information of a general or explanatory nature, which is not properly a part of the preceding sections. For example, when it is desirable to state the use for which the material or article is suitable, such statement appears in this section. References are made here to other specifications covering other types, grades, classes, etc., of the same or similar material or article. Citations to specifications followed without change of technical requirements or with slight deviations also appear here.

The Federal Specifications Board does not consider materials and devices of a strictly military nature, such as ordnance material, ammunition or explosives, military aeronautics, chemical warfare, general military equipment, materials used in connection with the construction of naval vessels, etc., unless specially requested to do so by the interested departments.

The circular establishing the Federal Specifications Board states that the specifications adopted and promulgated by the board shall be binding upon and govern all departments and independent establishments of the Federal Government, and was issued by the Director of the Bureau of the Budget, by direction of the President.

The Federal Specifications Board thus has one great advantage over all other standardizing bodies, in that the specifications officially promulgated are required by Executive authority to be used by all executive departments and independent establishments of the Federal Government. As a result, the board begins at once to accumulate data from the use of the specifications, which enables revisions to keep pace with the advances in the art of manufacture and the requirements of the service.

The Federal Specifications Board is represented on the following American Engineering Standards Committee sectional committees:

1. Numbering of steels.
2. Specifications for linseed oil (joint sponsor with American Society for Testing Materials).

The technical committees of the Federal Specifications Board are as follows, in the order of their formation:

1. Lubricants and liquid fuels.
2. Paints and oils.
3. Lumber.
4. Soap.
5. Rubber products.
6. Leather products.
7. Feeds and forage.
8. Refractories.
9. Electrical supplies.
10. Metals.
11. Builder's hardware.
12. Beds and bunks.
13. Fire-extinguishing liquid.
14. Sterlizing equipment.
15. Cordage.
16. Plumbing fixtures.
17. Textiles.
18. Wire rope.
19. Bituminous roofing and waterproofing compounds.
20. Pipe, fittings, valves, etc.
21. Floor covering (nontextile).

22. Heat-insulating materials (other than refractories).
23. Gaskets and packing material.
24. Coal.
25. Brushes and brooms.
26. Hand fire extinguishers.
27. Edible oils.
28. Safes (fire and petty larceny).
29. Paper.
30. Chinaware, glassware, stoneware, window glass, etc.
31. Brick and building tile.
32. Wood preservatives.
33. Provisions.
34. Plumbing fixtures (marine use).
35. Brake lining.
36. Inks and typewriter ribbons.
37. Portland cement, lime, and plaster.
38. Safes, burglar resisting.
39. Safety walkways (marine use).
40. Safety walkways (land use).
41. Road and paving materials.
42. Refrigerators.
43. Glue.
44. Telephones.
45. Abrasives and polishing materials.
46. Disinfectants.
47. Gauze and bandages.
48. Hand tools.
49. Machine screws, bolts, and nuts.
50. Photographic supplies.
51. Office furniture.
52. Shipping containers.
53. Commercial weighing and measuring devices.
54. Drafting equipment and supplies.
55. Office supplies.
56. Spraying machines (horticultural).
57. Thermometers.
58. Tableware and kitchen utensils.
59. Wearing apparel (nonmilitary).
60. Insecticides.
61. Stitches, seams, and stitching.
62. Miscellaneous chemical products.
63. Hair for mattresses and upholstery work.
64. Safety goggles, helmets, etc.
65. Radio apparatus.
66. Medical and surgical instruments, appliances, and supplies.
67. Gauges.
68. Color.
69. Tents and tent appliances.
70. Vacuum cleaners and carpet sweepers.
71. Laundry equipment.
72. Foundry apparatus and supplies.
73. Caskets and shipping cases therefor.
74. Standard wire screens and commercial wire screen cloth.
75. Storage batteries.
76. Motor-propelled vehicles.

Up to December 31, 1926, the board has adopted and promulgated 451 United States Government master specifications, for the mandatory use of all departments and independent establishments of the Government. For list of these specifications, see Bureau of Standards Circular No. 319.

In the selection of specifications for Government use, the Federal Specifications Board is collaborating with industry and is coordinating these two interests in a manner which is considered to best meet the requirements of the Government as a consumer.

In requesting comments and criticism on the proposed specifications from industrial groups, frequently differences of opinion will arise within an industry. In such cases it is the policy of the Federal Specifications Board to have the technical committee concerned hold open meetings for the full discussion of the questions at issue. Of course, the final decision as to the merits of the question under discussion must rest with the technical committee, subject to the approval of the Federal Specifications Board.

As the Federal Specifications Board specifications appear, they are oftentimes put into use by States, cities, and public institutions, and are also beginning to be widely used in industry. Thus the work of this board becomes of great influence throughout the Nation.

FEDERAL TRAFFIC BOARD

The Federal Traffic Board was formed by Bureau of the Budget Circular No. 41, of October 10, 1921, for the purpose of effecting economies and better business administration throughout the Government service in the handling of passenger transportation, shipment by freight, express, and parcel post, and for the utilization in a more practical way of the various available carrying facilities, both rail and water.

The board is composed of one representative from each of the larger departments and independent establishments of the Government, who is designated by the head of that activity.

The membership of the board is as follows:

Lieut. Commander C. E. Parsons (S. C.), United States Navy, coordinator for traffic, and chairman.

Department of Agriculture, Elmer E. Forbes.
Alien Property Custodian, G. G. Johnston.
Civil Service Commission, Miss Elizabeth Raymond.
Department of Commerce, N. N. Potts.
District of Columbia, J. W. Wimer.
Federal Board for Vocational Education, E. Joseph Aronoff.
Department of the Interior, C. E. Harris.
Interstate Commerce Commission, C. G. Jensen, jr.
Department of Justice, E. J. Matchett.
Department of Labor, George W. Love.
Library of Congress, Samuel M. Croft.
United States Marine Corps, Maj. Jeter R. Horton, appointed September 25, 1925, vice Charles R. Sanderson, relieved September 25, 1925.
Navy Department, Lieut. Commander R. K. Awtrey.
Panama Canal (The), W. J. Fisher.
Post Office Department, George W. Smith.
Government Printing Office, W. H. Kervin.
Railroad Administration, W. H. Quigg.
United States Shipping Board Emergency Fleet Corporation, C. T. Burley.
Smithsonian Institution, W. H. Kimball.
State Department, J. D. Johnson.
Tariff Commission, John F. Bethune.
Treasury Department, Irving J. Martin.
United States Veterans' Bureau, N. C. Reed.
War Department, Col. H. H. Sheen.

The board has full authority, subject to review by the chief coordinator, to pass on all questions pertaining to—

Establishment of uniform classifications for all commodities shipped by the Government.

Drafting of plans for improving and standardizing methods of making shipments and settlement of accounts.

Adjustment of all questions which require application of remedial measures, such as freight rates, switching, and terminal charges, etc.

The board functions by means of committees appointed by the chairman who is also the coordinator for traffic and, as such, the operating head of the board. All movements of Government freight, consisting of two carloads or more, from any department are routed by the coordinator for traffic who undertakes to provide the cheapest possible route for the shipment.

The coordinator for traffic has routed, for eight months of the current year, a total of 20,433 carloads of Government freight or an average of 2,554 carloads per month.

Standardized Government travel regulations prepared by the board were approved by the President August 11, 1926, and promulgated by the Director of the Bureau of the Budget effective October 1, 1926.

INTERDEPARTMENTAL BOARD OF CONTRACTS AND ADJUSTMENTS

This board was created by Executive order promulgated in Bureau of the Budget Circular No. 47 of November 22, 1921.

The board is composed of representatives from each department and independent establishment authorized by law to enter into important contracts. The membership of the board is as follows:

Gordon A. Ramsay, Bureau of the Budget, chairman; Maj. E. W. Cushing, Officers Reserve Corps, Bureau of the Budget, assistant to the chairman.

- Chief Coordinator, Brig. Gen. H. C. Smither, represented by Maj. Alfred H. Erck.
- Department of Agriculture, Josiah L. Carr.
- Department of Commerce, W. S. Erwin.
- Department of the Interior, Walter B. Fry.
- Department of Justice, Howard W. Ameli.
- Department of Labor, E. E. Salisbury.
- Navy Department, Rear Admiral H. H. Rousseau; alternate, Pickens Neagle, Solicitor for Navy Department.
- Post Office Department, Walter E. Kelly.
- Department of State, Jacob A. Metzger.
- Treasury Department, Gordon A. Ramsay; alternate, Ralph E. Day, Coast Guard.
- War Department, Lieut. Col. C. C. Whitcomb, appointed February 5, 1926, vice Col. Edwin P. Wolfe.
- Alien Property Custodian, G. C. Foster.
- District of Columbia, Roland M. Brennan.
- Employees' Compensation Commission, Samuel D. Slentz.
- Federal Board for Vocational Education, E. Joseph Aronoff.
- Federal Power Commission, Maj. Lewis W. Call, United States Army.
- Federal Trade Commission, F. C. Baggarly.
- Government Printing Office, George H. Carter.

Interstate Commerce Commission, R. Granville Curry, appointed October 6, 1925, vice J. C. Fort.
National Advisory Committee for Aeronautics, J. F. Victory.
National Home for Disabled Volunteer Soldiers, Col. C. W. Wadsworth.
Panama Canal (The), Noble Moore.
Smithsonian Institution, J. S. Goldsmith.
Public Buildings and Public Parks of the National Capital, James F. Gill, appointed April 14, 1926, vice E. F. Batchelor.
United States Botanic Garden, Wilmer J. Paget.
Housing Corporation, Thomas W. O'Brien.
United States Shipping Board Emergency Fleet Corporation, Clyde Wendelkin, appointed September 15, 1925, vice Harry Long.
Tariff Commission, J. F. Bethune.
United States Veterans' Bureau, C. W. Beery.

The purpose of the board is the standardization of contract forms and the adoption of uniform practices of interpretation and negotiation, both preceding and following the actual execution of such contracts.

The board standardizes, where possible, the method of contracting to the end that a uniform policy may control the making of contracts with a view to such changes in form of contracts as will tend to enlist the interest of the contractor in behalf of economy and promptness of execution, as well as to eliminate those uncertainties of construction and hazards to be assumed by the contractor which have operated to increase the cost of Government work and supplies.

The board recommends general policies in the settlement of outstanding obligations arising from contracts of the United States, and acts in an advisory capacity, when requested, to review and revise important contracts and agreements, to advise as to proper interpretation of contracts in process of execution, and to assist in the negotiations of important contracts and agreements relating to personal services, supplies, or construction work.

The board has completed the final draft of the following contract forms:

Standard form of government lease.
Standard form of government invitation for bids.
Standard government form of bid.
Standard instructions to bidders.
Standard form of government contract for construction work.
Standard form of government contract for supplies.
Standard form of government bid bond.
Standard form of government performance bond.

The board has also prepared a Digest of Decisions of the Supreme Court, the Court of Claims, and Opinions of the Attorney General Relating to Government Contracts, which has been published. This digest supplements the Compilation of Principal Federal Statutes Relating to Contracts, previously prepared by the board.

The board is at work on the draft of a proposed contract law entitled "A bill to establish uniform procedure in the making of Government contracts." This draft contemplates the repeal of many of the 225 existing statutes prescribing different formalities and different methods of procedure, and combines in 18 sections the essential provisions of law to safeguard the Government's interest and make Government contract procedure uniform.

INTERDEPARTMENTAL BOARD ON SIMPLIFIED OFFICE PROCEDURE

The board was created by the Bureau of the Budget Circular No. 137, dated May 16, 1924, under authorization contained in Executive Order No. 3578. The membership of the board consists of the chairmen of the several departmental committees on simplified office procedure with the Chief Coordinator as chairman.

Brig. Gen. H. C. Smither, U. S. A., Chief Coordinator, chairman.
Maj. A. H. Erck, U. S. A., Assistant Chief Coordinator, executive chairman.
Departments:
- State, E. J. Ayers.
- Treasury, F. A. Birgfeld.
- War, Brig. Gen. Lutz Wahl and Col. G. A. Nugent (alternate).
- Justice, J. W. Baldwin.
- Post Office, T. J. Howell.
- Navy, Capt. Frank H. Clark.
- Interior, W. B. Acker.
- Agriculture, C. W. Kitchen.
- Commerce, E. W. Libbey.
- Labor, S. J. Gompers.

Independent establishments:
- Library of Congress, W. L. Brown.
- Government Printing Office, J. K. Wallace.
- Interstate Commerce Commission, T. L. Haden.
- Civil Service Commission, W. L. Quaid.
- Federal Trade Commission, O. B. Johnson.
- United States Shipping Board, S. Goodacre.
- United States Veterans' Bureau, I. E. Scott and A. C. Fowle (alternate).
- Federal Board for Vocational Education, E. J. Aronoff.
- Panama Canal (The), R. L. Smith.
- National Advisory Committee for Aeronautics, E. H. Chamberlin.
- Federal Power Commission, F. W. Griffith.
- Commission of Fine Arts, H. P. Caemmerer.
- National Home for Disabled Volunteer Soldiers, Col. C. W. Wadsworth.
- Public Buildings and Public Parks of the National Capital, R. O. Jennings.
- Commissioners District of Columbia, D. E. Garges.

Upon the board devolves the task of aiding the departments and independent establishments interdepartmentally by taking under consideration all matters and subjects connected with the simplification and standardization of governmental executive office procedure not specifically allocated elsewhere by the Chief Coordinator. There is a tendency to lose sight of the benefits in the form of economy and

service efficiency that the General Government and those who deal with it may derive from simplified cooperative effort permitted by such standardization.

The standardization of office procedure and the standardization of forms are the two principal classes of subjects that the board considers. It conducts investigations and considers all questions relating to office procedure and makes studies of the forms proposed for standardization, including the subject matter, number of carbon copies that may be needed, and suitability for filing or other purposes. The board is also qualified to consider questions pertaining to personnel which have an interdepartmental aspect, and its function is to consider, pass upon, and advise with respect to them.

As a summary, its functions are to bring about a fruitful realization of greater economy and increased efficiency in the conduct of business by the various executive departments and independent establishments. The test of efficiency of the board is its ability to secure and maintain cooperation and coordination among the services in all matters and subjects that will lead to the elimination of waste of effort, money, and equipment.

The work of the board is performed largely by an executive committee of 11 members. The entire board is assembled only when questions of policy or other important matters are to be considered The executive committee investigates all matters brought to its attention and upon which it is authorized to act and make recommendations.

Since the activities of the board are confined to matters relating to office administration, the Chief Coordinator has authorized it to issue memoranda from time to time, in a numbered series, to the heads of departments and establishments for the purpose of securing comments on proposed plans for coordinating administrative procedure and for conveying information.

The departments and establishments present their written or oral views, all of which are carefully considered before definite recommendations are made to the Chief Coordinator. The Chief Coordinator refers all proposed standardized forms to the Permanent Conference on Printing for comment as to the size that may be conveniently cut from paper stock, the typography of the forms, and the substance, color, and quality of paper most suitable for the purpose for which the form is to be used. An agreement between the conference and the board has been made, as to the field that should be covered by each, in order that duplication of effort may be prevented. The contact which is maintained by mutual representation upon the conference and the board keeps this agreement alive.

Finally the results of the board's deliberations are submitted to the Bureau of the Budget for presentation to the President, and, if

approved by him, a numbered circular is issued to the heads of departments and independent establishments by the Bureau of the Budget promulgating the President's action.

The heads of departments and establishments then make requisition upon the Public Printer for such supplies as may be needed to meet the change in office administration, taking into consideration the stock of supplies on hand, and authorize the Public Printer to destroy any electrotype plates which may have been used in the printing of forms which are to be discontinued.

Should any department or establishment upon occasion consider it necessary to deviate from a standard form, practice, or regulation the proposed deviation is submitted by the head of the service to the board for consideration and recommendation to the Director of the Bureau of the Budget.

During the year 1926 nine blank forms in use by two or more departments and establishments were standardized and promulgated. The standardization of these forms reduced the cost of printing and enabled the Government Printing Office to make deliveries more promptly. Since the standard forms are kept in stock, requisitions may be filled promptly, with the result that it contributes to that sense of solidarity in the Government service so essential to efficiency and coordinated effort.

The board has made a tabulation of Governmental employees stationed in the District of Columbia who are able to translate various languages into English. Departments having letters or documents written in foreign languages which they are unable to have translated are privileged to call upon the executive chairman of the board for assistance in an endeavor to find a translator able to do the work. The bureaus have cheerfully given the services of translators and have taken upon themselves the task of mutual assistance which the work has necessitated. Documents, pamphlets, and letters comprising 17 different languages were translated during the year through this arrangement.

A study of the envelopes used in the Government service was made by the board in cooperation with the Permanent Conference on Printing. As a result it was found that expensive cloth-lined and rope envelopes could be eliminated and less expensive kraft envelopes of an equal or superior strength be substituted, and that the present variety in sizes and qualities could be reduced.

Also it was found that a reduction in varieties of envelopes could be made from time to time as the necessary adjustments were made, in the hope that ultimately a schedule of sizes and qualities might be devised which would be the minimum essential for efficient service.

Suitable space for filing the ever-increasing volume of public records having permanent value for historical or other purposes is costly and difficult to obtain.

The board invited the attention of departments to the desirability of organizing within each bureau or office a committee of experienced employees to determine, under proper supervision, what papers after definite periods automatically become of no further value. A policy for the periodic destruction of such papers could then be adopted and appropriate instructions issued by each department for making it effective. There would then be a regular destruction of useless papers, freeing for utilization considerable storage space now used for the keeping of records that have ceased to be of value.

Among other matters considered by the board there may be mentioned: The publication of an official gazette; a formula for making brown negative (Van Dyke) paper in department laboratories; the use of cheap grades of mimeograph paper for certain purposes; coordination of Government mimeograph facilities; uniform listing of Government activities in telephone directories; uniform regulations for leave of absence; use of pictorial posters for increasing the efficiency of Government employees; use of concentrated inks in field offices; the manufacture of rubber stamps and other articles by some Government services for others; requests for deviation from standard forms; and the use of knocked-down boxes for shipping certain classes of articles.

PERMANENT CONFERENCE ON PRINTING

The conference was organized under Executive order promulgated in Bureau of the Budget Circular No. 14 of July 22, 1921. The object of the conference is to investigate and propose uniform standards, businesslike methods, and proper economies in public printing and binding and the distribution of publications. It recommends reductions in the amounts of Government printing and binding through the elimination of unnecessary reports, bulletins, publications, etc. The conference standardizes and changes specifications where necessary to reduce cost of printing, scrutinizes requisitions from the various departments with a view to reducing the cost of work without impairing its usefulness. The conference investigates preparation of copy for printer; cost of authors' corrections; standardization of paper in relation to grades, sizes, weights, and colors; illustrations and printing in color; standard size forms and binding of publications; discontinuance of periodicals and annual reports; blank and loose-leaf forms and letterheads; rush work; duplication of departmental printing; distribution of public documents, and mimeographing and multigraphing.

The personnel of the conference is as follows:

Chairman, George H. Carter, Public Printer.
Secretary, Frank D. Smith, Department of Agriculture.
United States Tariff Commission, J. N. Stead.
House of Representatives, Leroy Brandon, Journal Clerk.
National Advisory Committee for Aeronautics, E. H. Chamberlin.
Railroad Labor Board, Robert F. Cole.
Post Office Department, F. A. Dony.
State Department, Tyler Bennett.
United States Shipping Board, J. G. Reckert.
Panama Canal (the), Mrs. M. W. Gillman.
Interior Department, Charles F. Glass.
United States Employees' Compensation Commission, Mrs. Lillian K. Stamm.
Federal Power Commission, F. W. Griffith.
General Accounting Office, H. A. Harding.
Bureau of the Budget, A. E. Surguy.
Board of Commissioners of District of Columbia, M. C. Hargrove.
Bureau of Efficiency, George C. Havenner.
Department of Agriculture, L. J. Haynes.
Alien Property Custodian, G. G. Johnston.
War Department, Henry C. Lehmann.
Department of Commerce, Thomas F. McKeon.
Department of Justice, H. C. Maull, jr.
Library of Congress, George W. Morgan.
Public Buildings and Public Parks of the National Capital, George C. Gist.
United States Botanic Garden, W. J. Paget.
Federal Board for Vocational Education, John Shaw.
United States Veterans' Bureau, Arthur H. Smith.
Department of Labor, Shelby Smith.
United States Court of Claims, J. Bradley Tanner.
Navy Department, J. E. Tibbitts.
Smithsonian Institution, W. P. True.
Office of Chief Coordinator, Maj. Alfred H. Erck.
Treasury Department, F. F. Weston.
Interstate Commerce Commission, L. D. Scisco.
Civil Service Commission, R. L. Woodward.
United States Board of Mediation, Robert F. Cole.
Federal Trade Commission, H. B. Stamm.

In order to clarify the question as to what forms should be considered for standardization and the relation of the Permanent Conference on Printing to the work of the Interdepartmental Board on Simplified Office Procedure, the conference adopted the following recommendation as submitted by its committee on standardization of forms:

That where a form can be so constructed as to meet the requirements of the various departments and establishments, the creation of such a form and its designation as a standard form is in the interest of economy and facility. In connection with forms prepared by one department or establishment for use in obtaining in uniform manner information from other departments and establishments, your committee recommends that forms of this character furnished to the departments or establishments by the office designing the form should remain

as a form of a particular department, but forms of this character which the departments or establishments are required to supply for their own use should cease to be a form of a particular department, and should be made standard forms.

A special committee of the conference cooperated with a committee of the Interdepartmental Board on Simplified Office Procedure in a study of standard sizes and quality of envelopes for the various services of the Government other than those purchased by the Public Printer. The report recommended the elimination of 62 envelope items from the list heretofore purchased on contracts awarded by the Post Office Department, and proposed the general substitution of kraft envelopes of the same or better strength for cloth-lined and rope envelopes.

The conference adopted the report of the envelope committee and concurred in its recommendations, with an amendment that the one Government contracting agency as proposed by the committee shall contract for envelopes "used by two or more departments or services of the Government."

At the request of the conference, the Public Printer instructed the style board of the Government Printing Office to prepare an abridged edition of the Style Manual of the Government Printing Office for the use of typists, clerks, and editors of the various departments in the better and more uniform preparation of copy for the printer. Proofs of the Style Manual Digest were submitted to the executive committee for its review with a representative of the Government Printing Office.

The conference was advised by the Public Printer that he had obtained authorization from Congress in the legislative appropriation act, approved May 13, 1926, to furnish inks, glues, and other supplies manufactured by the Government Printing Office in connection with its work to departments and other establishments of the Government upon requisition and payment from available appropriations. Some of these supplies, especially inks, have been developed by the testing section of the Government Printing Office in cooperation with several members of the conference, and it is expected that the procurement of these supplies from the Government Printing Office will result in substantial savings as well as better service.

The Joint Committee on Printing again invited the conference to designate a representative on its Special Committee on Paper Specifications which annually prepares the paper and envelope schedules for the Government Printing Office. The specifications committee made an important change in adopting 1,000 sheets as the unit of count and basis of weight, thus abolishing the 500-sheet ream for Government paper. This change conforms to the general trade practice recently adopted by printers and paper manufacturers and

36316—27——9

will greatly simplify the ordering and handling of paper, as the substance weight basis for the 1,000-sheet unit is simply double the old 500-sheet ream weight.

The conference has assisted the General Accounting Office in standardizing the paper stock and typographical appearance of various accounting forms promulgated by the Comptroller General.

Among the subjects considered by the conference during the past year were the standardizing of forms, envelopes, sizes of publications, and color of copying inks; the uniformity of binders' titles; the use of multigraphing, typesetting, and bindery machines by various branches of the Government service; the supplying of tabulating machine cards and printing materials by the Public Printer; and the establishment of a Government gazette. Definite action was not taken in regard to all these varied topics, but good progress was made in the standardization of forms and envelopes, which occupied much of the attention of the conference during the year.

UNITED STATES BUREAU OF EFFICIENCY

The functions of the United States Bureau of Efficiency, as prescribed by statutory authority, consist of the establishment and general supervision of a standard system of efficiency ratings for the classified service in the District of Columbia; the investigation of the needs of the several executive departments and independent establishments with respect to personnel requirements, and the investigation of duplication of work and methods of business in the various branches of the Government service.

The bureau has prescribed a uniform procedure for rating the efficiency of practically all employees in the classified departmental service regardless of the type of work on which they might be engaged. Annual efficiency ratings are now prepared by the executive departments and independent establishments.

UNITED STATES CIVIL SERVICE COMMISSION

In improving its methods of selecting personnel for the Federal service the commission aims to standardize those phases of its work in which such practice is feasible.

The following steps involve standardization of one or more factors of selection methods:

1. Compiling clear-cut specifications of duties performed.
2. Securing criteria as basis for scientifically determining the standards of proficiency as well as the relative value of the measuring devices which are tried.
3. Setting up standards of proficiency for the following:
    - (*a*) Performance. Example: Examination for typist.
    - (*b*) Knowledge. Example: Examination for economist.
    - (*c*) Aptitude. Example: Examination for post-office distributer.

4. Maintaining the standards of proficiency, by standardizing the following, for each examination:
   - (*a*) Scope of subject matter.
   - (*b*) Form in which subject matter is presented.
   - (*c*) Range and focus of difficulty.
   - (*d*) Time limit for examination.
   - (*e*) Procedure in administering examinations.
   - (*f*) Samples of forms and directions as to how they should be answered.
   - (*g*) Procedure in rating the papers.

The use of objective test forms has made possible much of this standardization. An objective test is one which contains questions requiring certain definite answers, the scoring of which does not depend on the subjective judgment of the examiner. The same answer in such a test receives the same credit, regardless of who rates the papers. In a subjective test, on the contrary, the score is obtained through the exercise of judgment; it may vary as examiners differ in ability to judge and in their standards of judgment.

With objective test forms, accurate data can be compiled as to the relative difficulty which different test items present to competitors. Thus it is possible to establish definite standards and maintain equality among alternative series of an examination. A score which is set in one year as the standard required for a given position represents the same standard in the following year, although an alternative series of the examination is used.

One example of the application of the process of standardization in the commission's work, during 1926, was the construction of three tests of general adaptability which cover the entire range of adaptability. Formerly this was measured by a large number of different tests. The advantages of the new tests are these: The three tests may be used in place of numerous forms previously required; they are constructed on the basis of one master scale, so that a score in any test may be translated into a score on the master scale; they are administered and scored objectively. The use of these comparable scales for a majority of civil-service positions will make possible improved methods of selection, placement, guidance, transfer, and promotion.

DISTRICT OF COLUMBIA

District Government.—The Commissioners of the District government are represented on the Federal Specifications Board, by the deputy purchasing officer. They are also represented on 10 technical committees of the Federal Specifications Board.

The District government has standardized the specifications for highway construction, sewer construction, and standard building regulations, as follows:

STANDARD BUILDING REGULATIONS.—The adopted building code of the District of Columbia contains nine volumes covering the following subjects:

Section I. Laws and regulations affecting building construction.

Section II. Administration, defining the duties of the inspector of buildings and staff, list of permit fees, and general information pertaining to the requirements for securing permits.

Section III. Precautions and safeguards, containing regulations governing use of public space for private purposes, protection of life and limb, and adjoining property, scaffolding, and plaster.

Section IV. Projections on public property, containing regulations applicable to projections beyond property lines.

Section V. Ventilation requirements pertaining to buildings utilized as places of public assemblage, for living, and workshop purposes.

Section VI. Means of egress and special requirements for occupancies, defining the types of exits as pertain to stairways, aisles, and corridors.

Section VII. Fire prevention and precaution regulations, providing for the classification of buildings from a construction standpoint and minimum requirements.

Section VIII. Structural-engineering requirements, pertaining to structural features of buildings defining minimum-load requirements, foundation, construction of walls, floors, and roofs.

Section IX. Elevators and dumbwaiters, containing regulations based upon latest information and recommendations of American Society of Mechanical Engineers, and containing modern requirements for elevator construction.

FEDERAL POWER COMMISSION

The standardization work of the commission, to date, has been limited to participation in the deliberations of the sectional committee on the rating of rivers of the American Engineering Standards Committee.

A representative of the commission is serving on that committee which is engaged in the formulation of standard methods of estimating and recording the power capacities of streams and rivers.

GENERAL ACCOUNTING OFFICE

One of the chief functions of the General Accounting Office is to prescribe and enforce a uniform system of reporting and accounting for the receipt, expenditure, and application of public funds, looking to legality and economy in their administration. For this purpose a legal division is maintained, whose duty it is to prepare briefs as the basis of official decisions, by which a uniform rule of interpertation of law and regulation is established with respect to each subject matter that is presented. It is a primary duty of the auditing and claims divisions of this office to enforce these decisions in auditing the accounts of accountable officers and settling claims which are presented for direct settlement, respectively. For the information of the various departments and establishments, syllabi of all decisions

are prepared, printed on daily synopsis sheets, and the sheets distributed to those concerned, while the more important decisions are printed in full in monthly pamphlet form, and later in annual bound volumes.

The principal activity of the office having to do with standardization work is the standardization of fiscal accounting forms and procedure and the making of the necessary investigations for this purpose.

Several Treasury Department circulars were issued in 1906 and 1907, which were signed jointly by the Secretary and the comptroller, culminating in Circulars Nos. 38, 52, and 62 of 1907, relating, respectively, to Treasury bookkeeping and statement of settled accounts; specimen and standard forms of voucher, pay roll, and account current and accounting procedure thereunder, and transportation forms and procedure. To the requirements of these and other similar circulars the departments and establishments adjust their accounting transactions and submit from time to time their forms and procedure for the approval of the comptroller. The forms published in the above circulars were, however, regarded as sample forms rather than standard forms, in the present acceptation of the term, and it was the practice to approve for each branch of the service such forms as it required, the same being printed for its special use in substantially the same form as the sample forms. This practice continued, with one exception, until the present organization of this office under the Budget and Accounting Act, when the work of complete standardization was undertaken in a more systematic manner.

The exception referred to is the inauguration of a standard transportation series of forms by Treasury Department Circular No. 49, June 19, 1915, by which the control of the printing of standard forms therein approved was placed in the Bureau of Engraving and Printing in case of transportation requests and in the Public Printer in case of bills of lading and transportation vouchers. The number of transportation-requests forms was reduced to four, which are printed and kept in stock by the Bureau of Engraving and Printing subject to requisition. Likewise, the vouchers are printed and kept in stock by the Public Printer, and distributed upon requisition directly to the transportation companies for their use. Little change in this respect has been made in the case of bills of lading, since each service has been allowed to retain its own forms provided they agree in all essential particulars with the standard series.

The success which attended the standardization of transportation forms, especially the vouchers, under an arrangement with the Public Printer as above indicated, established a precedent which it was thought best to follow. Accordingly, steps were taken to under-

take the work of completely standardizing accounting forms which pertain to the advance of funds, accounting for same (disbursements, transfers, deposits, etc.), collections of public moneys, and such other fiscal transactions as are required to be reported and accounted for to this office. In order to obtain full and complete information of the conditions and requirements existing in the various branches of the Government service and secure their cooperation in making effective use of the new standard forms to be adopted, the head of each department and principal establishment was requested on July 11, 1922, to appoint a representative, who would be authorized to speak for his department or establishment before a committee of such representatives, known as the advisory committee on fiscal accounting forms and procedure, on all matters properly coming before the committee.

The results of the deliberations and advice of the advisory committee and the action of this office to date thereon are as follows:

Standard forms Nos. 1013, 1013a, 1013b, 1013c,1013d, and 1013e (General Regulations No. 34 and Supplement No. 1, 1924), annual salary pay roll.

Standard forms Nos. 1012, 1012a, 1012b, and 1012c (General Regulations No. 36, 1924), reimbursement voucher for travel and other expenses.

Standard forms Nos. 1019, 1020, 1021, and 1022 (General Regulations No. 41, 1925), account current.

Standard forms Nos. 1024, 1025, 1026, and 1027 (General Regulations No. 43, 1925), schedules of disbursements and collections and requisition for disbursing funds.

Standard forms Nos. 1028, 1029, 1030, and 1031 (General Regulations No. 46, October 16, 1925, and Supplement No. 1, May 6, 1926), transportation request and identification card, respectively.

Standard forms Nos. 1034, 1034a, 1035, 1035a, and 1036 (General Regulations No. 51, June 18, 1926), public voucher for purchases and services other than personal, and abstract of agreement, etc.

In addition to the above, the following standard forms have been prescribed by regulation without reference to or advice from the advisory committee:

Standard form of check list and statement of depository account (General Regulations No. 31, 1923).

Standard form No. 1037 (General Regulations No. 57, September 3, 1926), affidavit re dependency allowances under act of June 10, 1922, 42 Stat. 625.

Standard form of telephone toll voucher, to be printed and used by telephone companies (Bulletin No. 9, May 18, 1926).

Standard forms of administrative appropriation and fund accounting (circular No. 27, July 21, 1926).

The designing of forms for use in connection with the uniform appropriation and fund accounting system, commenced in July, 1923, was continued during 1926, and 12 standard forms were approved for use with 4 types of bookkeeping machines. These forms have been so designed that the special features of the different machines are utilized in the preparation of the records, yet the information

obtained for report purposes is the same and the number of forms reduced to the minimum. This standardization will result in a great saving in the printing and binding bills of the several departments and establishments, as these 12 plates will replace many times that number required under the old practice of permitting each administrative department and establishment to design and print the forms required for its particular use.

Installations of the uniform accounting system have been made in the 29 bureaus and services of the various Government departments and establishments.

Another phase of standardization work that is being performed by this office, which is worthy of mention, is the uniform regulation of the administrative examination of accounts and claims by the respective departments and establishments. As the result of exhaustive investigations made from time to time, general regulations have been issued prescribing rules of examination as uniform as possible, with a view to eliminating all duplication and coordinating the work of the services concerned with that of this office.

On June 1, 1925, General Regulations No. 44 were published, prescribing a uniform system of symbols for appropriations and their use by administrative and other officers. Also, General Regulations No. 51, hereinbefore referred to as prescribing standard forms of purchase voucher, etc., further prescribed a uniform system of symbols for numbering contracts, by which the numbers given to the contracts by administrative officers in accordance with the system will be used by this office in referring to and in filing them.

GOVERNMENT PRINTING OFFICE

The chief of tests, Government Printing Office, represents that activity on the executive committee, Federal Specifications Board, and the office is represented on seven technical committees of the board.

In accordance with section 3 of the printing act of June 12, 1895, the Joint Committee on Printing is designated to set the standards for paper for the public printing and binding. A subcommittee to prepare specifications for paper for the use of the Government Printing Office is therefore appointed by the Joint Committee on Printing. All specifications prepared by this subcommittee must be approved by the Joint Committee on Printing consisting of:

George H. Moses, Senator from New Hampshire, chairman.
Edgar R. Kiess, Representative from Pennsylvania, vice chairman.
George Wharton Pepper, Senator from Pennsylvania.
Duncan U. Fletcher, Senator from Florida.
Edward M. Beers, Representative from Pennsylvania.
William F. Stevenson, Representative from South Carolina.
Ansel Wold, clerk.

The testing section of the Government Printing Office is designated by the Public Printer to assist in the preparation of paper specifications and to prepare standard specifications for all materials used by the office. In conducting technical investigations in this connection, cooperative work is conducted with the manufacturers of materials used in the printing industry, in order to establish methods for testing, and to develop standard specifications.

Investigations relative to the standardization of paper, based on technical quality, are being conducted in cooperation with the United Typothetae of America and the paper manufacturers. The technical work in this connection is conducted by the testing section of the Government Printing Office. Investigational work on paper standardization has thus far covered only those papers commonly known as bonds and ledgers. The paper manufacturers have submitted, upon request, two sets of their regular mill brands of bond and ledger papers, one set in 1924 and one in 1925, which have been completely tested and the results published in tabulated form.

As a result of this work, tentative specifications for bond and ledger papers have been proposed and a conference with the paper manufacturers and the United Typothetae of America will be held in the near future for the purpose of taking action on the proposed specifications. The proposed specifications for bond and ledger papers have been approved by the Joint Committee on Printing for the purchase of all papers used by the Government Printing Office. It is proposed to extend this work on paper standardization to cover all grades of paper commonly used by the printing office.

As a result of the work on materials other than paper so far conducted by the testing section, standard specifications have been adopted for bookbinding cloths of all kinds, bookbinding leathers, imitation leathers, and flax book twine. Investigations are now under way for the purpose of developing standard specifications for pigments and varnishes used in the manufacture of printing inks and also for bookbinding threads. Tentative standards for these materials have already been prepared.

In connection with the technical control work carried out by the testing section of the Government Printing Office, standardization work is also being conducted relative to alloys for use on various kinds of typesetting machines and for various kinds of printing, such as stereotyping, electroplating, etc.

The testing section of this office has also conducted standardization work for the purpose of establishing standard methods for the testing of glue and to develop specifications covering the various qualities necessary for use by the printing industry. As a result of this work, the test methods recommended by the National Association of Glue Manufacturers have been adopted for measuring the viscosity and

jell strength of glue and tentative specifications developed for the purchase of this material for the use of this office.

INTER-AMERICAN HIGH COMMISSION—UNITED STATES SECTION

In cooperation with the United States Department of Commerce, the section has prepared and distributed a large number of pamphlets in which are reproduced in French and Spanish as well as English specifications for various commodities formulated by the American Society for Testing Materials and the standards of the American Institute of Electrical Engineers.

In cooperation with the Pan American Union, the section has been instrumental in organizing the Pan American Standardization Conferences, the first of which was convened in Lima, Peru, in January, 1925, and the second of which will be held in Washington, D. C., in May 1927.

INTERSTATE COMMERCE COMMISSION

The Interstate Commerce Commission is represented on the Federal Specifications Board by the chief clerk. The commission is represented on two technical committees of the board.

The Interstate Commerce Commission prescribes standard systems of accounts for steam roads, water carriers, electric railways, sleeping-car companies, express companies, pipe-line companies, telephone companies, and telegraph and cable companies, subject to the interstate commerce act. All such carriers are required to file annual reports with the Interstate Commerce Commission on standard forms prepared by the commission.

The commission prescribes the manner in which carriers, subject to the act, shall prepare their publications containing the rates, charges, and regulations applicable to interstate commerce.

The commission prescribes regulations for the transportation of explosives and other dangerous articles by freight and express and as baggage, including specifications for shipping containers.

The commission, under authority of law, has prescribed the safety appliance standards of freight and passenger train cars; the rules and instructions for the inspection and testing of locomotives and their appurtenances, and specifications for automatic train-stop or train-control devices.

The commission also fixes the limits of the standard time zones for the continental United States and Alaska.

LIBRARY OF CONGRESS

The Library of Congress promotes standardization through the production and dissemination of standard catalogue cards. In size, 3 by 5 inches, and in the form of "entry," these cards embody deci-

sions representing the consensus of professional and expert opinion in American libraries. They are produced for use in the Library of Congress catalogues, but extra copies are printed not merely for free distribution as a whole to some 50 institutions, but for sale to others and to individuals. This practice aids standardization of library practice in this major library activity. The library encourages the need of an international library cataloguing code, and its modifications of this from time to time are generally accepted.

The system of classification in use in the Library of Congress has been definitely adopted by over 70 libraries, including some abroad, and is therefore standard for them.

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

The National Advisory Committee for Aeronautics was established by act of Congress approved March 3, 1915.

The committee has 12 members, appointed by the President. The law provides that the personnel of the committee shall consist of two members from the War Department, from the office in charge of military aeronautics; two members from the Navy Department, from the office in charge of naval aeronautics; a representative each of the Smithsonian Institution, the United States Weather Bureau, and the National Bureau of Standards; and not more than five additional persons acquainted with the needs of aeronautical science, either civil or military, or skilled in aeronautical engineering or its allied sciences. The law further provides that all members as such shall serve without compensation.

Revision of Nomenclature for Aeronautics.—Since aeronautics is a rapidly advancing science, the need arises from time to time for revision of its official nomenclature. Five reports on this subject have been issued by the committee: The first in 1917; the second in 1918; the third in 1919; the fourth in 1920; the fifth, known as report No. 157, in 1923.

In October, 1924, a special conference on aeronautical nomenclature was organized by the committee, its membership including officially designated representatives of the Army Air Service, the Bureau of Aeronautics, of the Navy Department, the National Bureau of Standards, the Society of Automotive Engineers, the American Society of Mechanical Engineers, and the Aeronautical Chamber of Commerce of America. As the number of terms suggested for inclusion in the official nomenclature had greatly increased since the publication of the last report on the subject, the task of revision was much greater than ever before, and to facilitate its execution the entire nomenclature was divided into four main sections and a subcommittee appointed to study and agree upon the terms for each

section. These four subcommittees were as follows: Airship terms, aerodynamic terms, power-plant terms, and airway terms.

The four sections of the nomenclature, after revision by these subcommittees, were submitted to and approved by the conference as a whole, and the entire nomenclature was officially approved by the executive committee on September 19, 1925. The new nomenclature will be published in the near future as a technical report, and will supersede all previous publications of the committee on the subject.

Adoption of Standard Atmosphere.—In response to the need for a national standard of certain basic physical constants for use in connection with aeronautical calculations relating to pressure, temperature, and density relations in a normal or standard atmosphere, the committee on aerodynamics took up the question, and, after careful consideration and agreement between representatives of the Army Air Service, the Bureau of Aeronautics, of the Navy Department, the United States Weather Bureau, and the National Bureau of Standards, recommended the adoption of a set of values, known as the standard atmosphere.

On December 2, 1924, this standard was officially approved by the executive committee, and, on recommendation of the committee, has since been adopted for use in aeronautical calculations by the War and Navy Departments, the Weather Bureau, and the National Bureau of Standards.

Tables and other reference data based on this standard have been prepared for laboratory use, and are being published as technical report No. 218 of the committee, entitled "Standard Atmosphere—Tables and Data."

Adoption of Altimeter Calibration Standard.—On suggestion of the aeronautic instruments section of the National Bureau of Standards, this committee organized a special conference on altimeter calibration standards as a subcommittee of the committee on aerodynamics, for the purpose of formulating and recommending a new national standard for the calibration of altimeters. The altitude pressure relation previously in use in this country for the calibration of altimeters was based on the assumption of a constant temperature of +10° C. at all altitudes, which differed widely from the average temperatures actually experienced, and hence caused altimeter readings to deviate considerably from the true altitude in many cases. It was, therefore, deemed desirable that a new standard be adopted which would be more nearly in agreement with actual conditions.

The special conference on altimeter calibration standards included in its membership representatives of the engineering division of the Army Air Service, the Bureau of Aeronautics, of the Navy Department, the Weather Bureau, the National Bureau of Standards, the

National Aeronautic Association, and this committee. A meeting of the conference was held on December 6, 1924, at which the new standard was agreed upon for recommendation to the committee on aerodynamics. This standard was approved by the executive committee on February 18, 1925, on recommendation of the committee on aerodynamics, and has since been adopted by the War and Navy Departments, the Weather Bureau, and the National Bureau of Standards.

Standard Method for Determination of High-Altitude Performance.—In response to a general feeling among the organizations in this country, that the methods used by the Féderation Aeronautique Internationale for the determination of altitudes in comparing high-altitude performance of airplanes were not sufficiently accurate, a special conference on standard method of comparing high-altitude performance was organized as a subcommittee of the committee on aerodynamics. The membership of this special conference included representatives of the Army Air Service, the Naval Bureau of Aeronautics, the Weather Bureau, the National Bureau of Standards, the National Aeronautic Association, and this committee.

A meeting of this conference was held on June 3, 1925, at which a standard method for the determination of high-altitude performance of aircraft was agreed upon for recommendation to the National Aeronautic Association, which is the official representative in this country of the Féderation Aeronautique Internationale. On recommendation of the committee on aerodynamics, this standard was transmitted on June 10, 1925, to the president of the National Aeronautic Association, with a view to its presentation at the annual conference of the Féderation Aeronautique Internationale.

Standardization of Wind-Tunnel Results.—For the past several years tests have been conducted in various wind tunnels in this country and abroad on series of standard models with a view to bringing about a standardization of wind-tunnel results by a comparison of the results of these tests.

Three cylinder models having a length ratio of 5 : 1 and four models of the United States Army 16 airfoil having an aspect ratio of 6 : 0 and lengths varying from 18 to 36 inches have been tested during the past year at the Massachusetts Institute of Technology, and tests are now under way at McCook Field. These models had previously been tested at the Langley Memorial Aeronautical Laboratory, the Washington Navy Yard, and the National Bureau of Standards. The tests in all the wind tunnels on these models were conducted over as wide a range of V/L as possible and included the determination of lift, drag, and pitching moment for every 4° from −4° to +20° C.

Tests have also been conducted at the request of the Aeronautical Research Committee of Great Britain on airship and airfoil models constructed by the National Physical Laboratory. During the past year a joint report on the results of the tests in this country of the National Physical Laboratory, Royal Air Force, 15 airfoil model has been prepared as the result of a conference between the heads of the various laboratories at which the tests were made. This report, in accordance with a recent agreement with the Aeronautical Research Committee, will probably be published in this country in the near future. An exact copy of the National Physical Laboratory airship model is undergoing test in the variable-density wind tunnel of the committee for comparison of the results with those obtained in the wind tunnels of the atmospheric type.

During the past year the program of standardization tests for the wind tunnels of this country has been extended to include tests of three geometrically similar disks 4, 8, and 12 inches in diameter, respectively. These disks have been constructed and have been tested at the Langley Memorial Aeronautical Laboratory, and will later be tested in the wind tunnels at the Washington Navy Yard, the National Bureau of Standards, the Massachusetts Institute of Technology, and McCook Field.

On request of the Aeronautical Research Committee of Great Britain, the committee is now testing in its variable-density wind tunnel at Langley Field a model of the Royal Air Force 15 wing section on a Bristol fighter airplane, a model of the Royal Air Force 19 wing section on a BE–2E airplane, and a model of the Royal Air Force 30 section on a Bristol fighter airplane, for comparison with the results of wind-tunnel and full-scale tests conducted on these sections in England.

In response to suggestion of the Aeronautical Research Committee that valuable information might be obtained if a metal-propeller model which has been tested in this country in an open-type wind tunnel could be sent to England and tested in one of the closed-type tunnels of the National Physical Laboratory, the committee forwarded to England for this purpose a metal-propeller model which had previously been tested in the open-type wind tunnel at Stanford University.

Standardization of Aeronautical Symbols and Abbreviations.—During the past year the American Engineering Standards Committee has had under way a program for the simplification and standardization of symbols and abbreviations used in technical and scientific fields. This program is being carried out by a sectional committee on scientific and engineering symbols and abbreviations of the standards committee, the sponsors for which are the American Association for the Advancement of Science, the American Institute

of Electrical Engineers, the American Society of Civil Engineers, the American Society of Mechanical Engineers, and the Society for the Promotion of Engineering Education.

The National Advisory Committee for Aeronautics has cooperated in this project in the preparation of the proposed standard symbols for aeronautics. Dr. Joseph S. Ames, chairman of the executive committee and of the subcommittee on aerodynamics of the National Advisory Committee, acted as chairman of the subcommittee on aeronautics of the sectional committee on scientific and engineering symbols and abbreviations. The following organizations were represented on this subcommittee, in addition to the National Advisory Committee for Aeronautics: The Army Air Corps, the Naval Bureau of Aeronautics, the National Bureau of Standards, the United States Weather Bureau, the Air Mail Service of the Post Office Department, the American Society of Mechanical Engineers, the Society of Automotive Engineers, and the Society for the Promotion of Engineering Education. A meeting of the subcommittee was held on April 23, 1926, and a list of aeronautical symbols was recommended for approval as American standard. This list is now being considered by the sectional committee.

American Aeronautical Safety Code.—The final draft of the Aeronautical Safety Code was approved by the sectional committee that is sponsored by the National Bureau of Standards and the Society of Automotive Engineers (Inc.) on April 23, 1925, and was subsequently submitted to and approved by the sponsors, who referred it to the American Engineering Standards Committee for final approval as a tentative American standard. The code has been prepared in printed form and may be obtained from the society.

The sectional committee is widely representative of the aeronautical interests and functions under the procedure of the American Engineering Standards Committee, the principal organizations represented on the sectional committee being the Aeronautical Chamber of Commerce, American Institute of Electrical Engineers, American Society of Mechanical Engineers, American Society for Testing Materials, American Society of Safety Engineers, Manufacturers Aircraft Association, National Aeronautic Association, National Aircraft Underwriters' Association, National Advisory Committee for Aeronautics, National Safety Council, Rubber Association of America, Society of Automotive Engineers (Inc.), Underwriters Laboratories (Inc.), National Bureau of Standards, United States Forest Service, United States Navy Department, United States Post Office Department, United States War Department, and United States Weather Bureau.

The committee is a continuing one, subject to call by the sponsors to reconsider the code in part or as a whole whenever it may seem

advisable to do so, although it is felt that such revisions should not be necessary for some time because of the care that was taken in preparing the code. It has been the objective of the committee to prepare a code that will promote general agreement and mutual understanding as to acceptable practices for safety in the construction and performance of aircraft, but not to prescribe too closely the methods of design, construction, or operation. It is hoped that on this basis the code will prove to be a valuable guide to designers, constructors, and operators of both aircraft and airdromes in advancing the development of commercial aviation, and to constituted authorities in enforcing regulations that may be enacted to govern this branch of the transportation service and industries.

NATIONAL SCREW THREAD COMMISSION

The National Screw Thread Commission was authorized by an act of Congress approved July 18, 1918 (Public Act No. 201, H. R. 10852, 65th Cong.). The life of the commission, which was originally fixed at six months, was extended from time to time by subsequent legislation, and on April 16, 1926, the commission was made a permanent body by removal of the time limit. (Public Act No. 125, H. R. 264, 69th Cong.)

The duties of the commission, as set forth in the above acts, are to—

> * * * ascertain and establish standards for screw threads, which shall be submitted to the Secretary of War, the Secretary of the Navy, and the Secretary of Commerce for their acceptance and approval. Such standards, when thus accepted and approved, shall be adopted and used in the several manufacturing plants under the control of the War and Navy Departments, and, so far as practicable, in all specifications for screw threads in proposals for manufactured articles, parts, or materials to be used under the direction of these departments.

The commission is composed of nine members. The Director of the National Bureau of Standards is ex-officio chairman of the commission, and of the eight additional members two are appointed by the Secretary of War, two by the Secretary of the Navy, and four by the Secretary of Commerce. Of the latter, two are from nominations made by the American Society of Mechanical Engineers and two from nominations made by the Society of Automotive Engineers.

The field of ordinary bolts and nuts for holding purposes has been well covered by the commission, two reports having been issued; a progress report in 1921 (Misc. Pubs., Bureau of Standards, No. 42), and a revised report in 1924 (Misc. Pubs., Bureau of Standards, No. 61). A complete classification of screw-thread fits has been set up, including dimensions and tolerances for all classes except the wrench-tight or interference fit. The reports also contain specifications and tolerances for fire-hose threads, small hose threads, and pipe threads.

The revised report also contains many helpful suggestions with reference to tap drills, threading tools, and gauges.

Most of the standards set up by the commission have been approved by the American Engineering Standards Committee as American standards.

The commission has also cooperated with a sectional committee organized under the rules of procedure of the American Engineering Standards Committee in setting up standard dimensions and tolerances for bolt heads, nuts, and wrench openings. A report has been completed, which is now in the hands of the sponsor bodies for approval and promulgation as an American standard.

In April, 1926, the commission participated in a series of Anglo-American and international conferences looking toward the international standardization of screw threads. While no changes in screw-thread standards were agreed upon, many points of common interest were developed, and certain common problems discussed with a view to establishing a definite and uniform practice with reference to thread forms and clearances.

The commission has also cooperated with the American Petroleum Institute in an extensive program of standardization of oil-field equipment, especially threaded joints for well casing, and cable-drilling tool joints and gauges. Four complete sets of master gauges for the cable-drilling tool joint which have been designed and constructed for the institute have been inspected and approved by the National Bureau of Standards. One of these sets is deposited at the bureau for use as a master reference set and the others have been distributed—one set to each of the important oil-producing regions. Through the use of these regional master gauges the oil industry throughout the country is now working to a single standard for this product in which complete interchangeability is of great importance.

A supplement to Section IV of the 1924 Report of the National Screw Thread Commission was adopted March 17, 1926, adoption confirmed May 5, 1926, by the commission giving tables of specific values of pitch diameter tolerances intended to cover nearly all practical combinations of diameter, pitch, length of engagement, and class of fit. These tables will greatly facilitate the specifications of dimensions on drawings of special fastening screw threads.

The commission now has before it the proposal of an extension of the national fine thread series above 1½ inches, with pitches somewhat coarser than those given in the 1921 progress report, to provide for general practice in the manufacture of bolts, nuts, and studs. In addition, a special 12-pitch series covering sizes from ½ inch to 3 inches is proposed to include the series in use in railroad practice and for use, wherever possible, for all applications requiring special threads.

The increasing use of ground-thread taps in industry has developed a fuller knowledge of the technical phases of their application and shown the great desirability of developing a single standard for their thread dimensions which will meet the major needs of industry. At its meeting on June 28, 1926, the National Screw Thread Commission appointed a subcommittee to form a larger committee which includes representatives of the Tap and Die Institute and of two large users of ground taps, to develop such standard tables of dimensions and tolerances. The new tables will replace those now published in the 1924 National Screw Thread Commission Report and by the Tap and Die Institute.

The commission is now giving its attention to several projects not covered by the reports so far issued. Among these the following may be mentioned:

Dimensions and tolerances for wrench-tight fits, such as studs to be permanently set in cast iron, aluminum, etc.

Special threads for use in the electrical industry.

Acme, square, and other special threads.

Hose connection threads for cutting and welding torches (completed).

Threads and gauges for cable drilling tool joints (completed).

Dimensions and tolerances for ground thread taps.

Fine thread series above 1½ inches.

While the use of the standards established by the commission is mandatory only in the case of establishments operated by or under the control of the War and Navy Departments, the standards so far established have come into very wide voluntary use outside of the Government, and their wide acceptance in the industries manufacturing or using screw threads has resulted in very great economic saving, through increased interchangeability of products and decreased rejections, stocks, and carrying charges.

THE PANAMA CANAL

The Inspecting Engineer of the Panama Canal represents that activity on the Executive Committee of the Federal Specifications Board.

The Panama Canal is represented on 34 technical committees of the Federal Specifications Board.

The Panama Canal is represented on the main and executive committees of the American Engineering Standards Committee. It is also represented on the American Society for Testing Materials committees on cement and screen wire cloth.

The Panama Canal makes use of the United States Government master specifications as far as they are applicable. Where no Federal specifications are in existence covering any particular material it has been found desirable in many instances to use the Navy specifications. However, in cases where the Panama Canal

has found that there were no specifications in existence which would insure their receiving material suitable for their requirements, the authorities at the Canal Zone have endeavored to compile proper data to be used as a basis for a specification, which often entails considerable research work, and as a consequence the Panama Canal has been obliged to issue a number of specifications.

SMITHSONIAN INSTITUTION

Astrophysical Observatory.—When in 1902 the observation of solar radiation, on which the temperature of the earth and all life depends, was begun by the Smithsonian Astrophysical Observatory, there were no instruments in existence capable of measuring the energy of radiation to within 5 or 10 per cent, and the disagreement between different varieties of supposedly standard instruments in this field reached as much as 50 per cent. Accordingly there was chosen for the work two types of standard pyrheliometer and one type of secondary standard pyrheliometer as follows:

1. The standard water-flow pyrheliometer, capable of receiving and completely absorbing solar heat, measuring the same to a small fraction of 1 per cent, and checking the measurements by observations on electrically introduced heat which were recovered in measuring to within a small fraction of 1 per cent.
2. The standard water-stir pyrheliometer, having similar characteristics to the water-flow pyrheliometer but employing different principles of measuring.
3. The secondary silver-disk pyrheliometer, more applicable to daily use. Over 50 copies of this instrument have been prepared, standardized at the Smithsonian Institution, and sent out, at cost, to a large number of the countries of the world, including England and several of its dependencies, France, Germany, Spain, Chile, Russia, Switzerland, and various of the continental and insular parts of the United States.

Thus, the Smithsonian Institution furnished the standard scale of solar radiation measurements to the world, and the measurements in other countries are usually reduced to this standard in present publications.

The methods of measuring the solar radiation have also been reduced to a standardized system. Full descriptions of the apparatus and methods are published in Volumes II, III, and IV of the Annals of the Astrophysical Observatory.

National Museum.—The principle of standardization was not only recognized but extensively practiced at the time of the organization of the modern National Museum. The sizes and character of the exhibition cases were reduced to certain units and their multiples. The colors of backgrounds and of walls of the exhibition rooms were standardized. The size, color, and type of labels were standardized and reduced to units. The storing of the study collections came in for particular attention. The standard storage unit case, with its three-quarter unit, half unit and quarter unit cases, in which our

present complement of tens of thousands of drawers are now interchangeably used throughout the Museum, was adopted as a foundation and has proven a saver of time, labor, and money.

The present unit system of the insect cases followed the office furniture, and later even stationery came in for this standardization.

In the scientific work standardization has progressed satisfactorily. The metric system has long since been adopted. The international efforts of zoologists and botanists to standardize their methods, terminology, and nomenclature have had sympathetic cooperation and material assistance from the Museum. The publications have likewise had the principle of standardization progressively applied to them. Citations and abbreviations have been reduced to standard rules, synoptic keys have been simplified according to standard principles, etc.

Specific instances of work of the character referred to above are the publication of the opinions rendered by the International Commission on Zoological Nomenclature, of which commission two officers of the Museum are members, and the publication in "The Auk," volume 43, No. 3, July, 1926, of "The Revised Classification for the Fourth Edition of the A. O. U. Check List." Similar standards are set up in many of the Museum monographs.

UNITED STATES GEOGRAPHIC BOARD

This board passes on all unsettled questions concerning geographic names which arise in the departments, as well as determines, changes, and fixes place names within the United States and its insular possessions, and all names suggested by any officer of the Government are referred to the board for consideration and approval before publication. The decisions of the board are accepted by all of the departments of the Government as standard authority.

UNITED STATES SHIPPING BOARD, EMERGENCY FLEET CORPORATION

This activity is represented on the executive committee, Federal Specifications Board, by the assistant director of supplies. It is also represented on 26 technical committees of the Federal Specifications Board.

The Shipping Board is represented on the American Engineering Standards Committee sectional committee on electrical installations on shipboard.

The Shipping Board collaborates with the following organizations on standardization work:

American Marine Standards Committee.
American Society for Testing Materials.
American Petroleum Institute.
Steamship Owners Association.

Fuel Conservation Committee.—The director of operations of the Emergency Fleet Corporation has formed a committee to establish standards of fuel cousumption for port and sea performance of the active vessels of the Government merchant marine fleet. Members for this committee are selected from the organizations listed below:

Department of maintenance and repair, United States Shipping Board.
Fuel section, United States Shipping Board.
The Society of Naval Architects and Marine Engineers.
The American Society of Mechanical Engineers.
The American Bureau of Shipping.
The Marine Engineers Benevolent Association.
The operating managers of United States Shipping Board.
Marine publications.

The object of the committee is to promulgate and institute such modifications in equipment and system of operation as will effect fuel economy without disturbing the traffic requirements of the fleet.

Results obtained by the committee:

Standards based on fuel per mile at various drafts and speeds for 76 classes of vessels have been established.

Port standards based on various allowances for handling cargo, length of port stay, etc., have been established.

Systematic inspection of vessels and analysis of performance is maintained.

Comparison of performance of sister vessels is transmitted to various operators.

Honor roll of best performers of fleet is published semiannually and bonus awarded best performers. (Maximum award, 50 vessels.)

Research is conducted as to improved methods of operation and equipment, especially combustion of cheaper grades of fuel.

Maintains liaison between United States Shipping Board and other Government departments in reference to means of effecting fuel economy, especially in connection with fuel oil testing plant of United States Navy.

Operates fuel school in conjunction with United States Navy for officers of Merchant Marine.

Follows up all modification in equipment to determine actual results obtained in service.

Acts in advisory capacity to privately owned vessels of the American Merchant Marine, to assist them in setting up a system whereby they can carry out the scheme which is in effect on the Government-owned vessels.

Current activities.—

Active participation in the items listed above.

Actively engaged in connection with United States Navy, Bureau of Mines, and private manufacturers in carrying on a program of tests to determine the feasibility of using pulverized coal for marine purposes.

Extending the program of fuel conservation so as to incorporate the various other items of expense of merchant vessels such as repairs, stevedoring, supplies, etc.

Accomplishments in 1926.—The Fuel Conservation Committee effected a reduction in the fuel costs of the Government fleet of $350,000, as compared to 1925. This is in addition to a saving made in 1925, amounting to a $2,500,000 reduction as compared to 1922. This saving is determined by multiplying the total miles traveled

by the Government-owned vessels in 1926 by the reduction in the fuel-per-mile factor, plus the product obtained by multiplying the total port hours of the fleet by the reduction in fuel consumption per hour for port service.

UNITED STATES VETERANS' BUREAU

The Veterans' Bureau is represented on the Federal Specifications Board by the assistant chief, purchase and issue subdivision of the supply division.

The bureau is represented on 32 technical committees of the Federal Specifications Board.

There is in the coordination service of this bureau a division designated as the "standardization division," but the coordination service as a whole, which includes the investigation, evaluation, and standardization division, is responsible for all work of standardization and coordination.

The functions of the service are to make audits, investigations, and inspections; to obtain, compile, and evaluate statistical data; to prepare estimates of needed appropriations and maintain control of the budget; to supervise the application of the classification act of 1923 in the United States Veterans' Bureau; to assist in the standardization of organization, policy and procedure. The service can recommend modification of any principles or practices upon the basis of facts found through study, investigation, evaluation, or by any step in the coordinating process.

The procedure includes the following steps: The finding of original facts by personal contact or through original correspondence, investigation reports, authentic statistical compilations, etc., and after evaluation of the data for determining needs, criteria of accomplishment, etc., the pointing out, upon the basis of facts found, of the indicated standards and necessary principles and practices, and the testing of their practicability by coordinating them through consultation or communication with the organization units whose activities are affected.

The current activities include the completion of work previously begun relating to the standardization of:

Personnel specifications.

Salaries.

Criteria for determining the number and distribution of employees in some of the different classes of work in which requirements can be estimated by production measurement.

Criteria for determining the best methods and procedure for conducting various activities with special reference to the further development of standardized methods in the more technical operations, such as rating, etc.

The number and content of forms required for carrying out the procedure.

The improvement of organization in central office and its field offices.

Budget control.

The principal accomplishment of the bureau in standardization for the year 1926 was the placing in operation, effective January 1, 1926, of a Standard Schedule for Rating Disabilities. This schedule comprises two tables, the first of which shows occupational variants which express the functional importance of 17 body parts in each of approximately 1,000 occupations, the variants having been determined by a statistical process of combining and coordinating the judgments of experts regarding the degree of functioning required of each body part in performing the operations of each occupation. The second table classifies by diagnosis and according to extent and severity the common disabilities which have been disclosed by the examination and observation of World War veterans, and expresses under the appropriate occupational variants the percentage (or the range of the percentage) impairment in earning capacity caused by the effect of the disabilities upon the respective body parts in reducing the individual's ability to do the work of each of the listed occupations. This table was designed to eliminate the disparities in rating which previously existed and to establish a standard rating procedure whereby each individual might be rated upon the basis of the impairment of earning capacity (in the occupation in which he was employed at the time of enlistment) caused by disabilities incurred in or aggravated by his military service.

Much has been accomplished by the bureau during this year also toward reducing the number of employees and the general overhead expense through the standardization of personnel requirements and the standardization of methods and procedure.

FEDERAL GOVERNMENT RESEARCH AND TESTING LABORATORIES

These laboratories are primarily intended for research and testing for the Government service, and their services, in general, are not available to the public for commercial testing, except that under certain regulations, prescribed by law, some of the laboratories, including the National Bureau of Standards, are available for special tests in the public interest.

A list of nongovernmental laboratories available for commercial testing will be found in Bureau of Standards Miscellaneous Publication No. 90.

Department of Agriculture:
- Bureau of Chemistry, 216 Thirteenth Street SW., Washington, D. C.
- Bureau of Public Roads, 515 Fourteenth Street NW., Washington, D. C.
- Bureau of Soils, Twelfth and B Streets SW., Washington, D. C.
- Forest Products Laboratory, University of Wisconsin, Madison, Wis.
- Insecticide and Fungicide Board, 220 Thirteenth Street SW., Washington, D. C.
- Weather Bureau, Twenty-fourth and M Streets NW., Washington, D. C.

Department of Commerce:
- Bureau of Fisheries, Sixth and B Streets SW., Washington, D. C.
- Bureau of Lighthouses, Tompkinsville, N. Y.
- Bureau of Mines, main laboratory, 4800 Forbes Street, Pittsburgh, Pa.
  - Branch laboratory—
    - Fairbanks, Alaska.
    - University of Utah, Salt Lake City, Utah.
    - University of Nevada, Reno, Nev.
- National Bureau of Standards, main laboratories, Connecticut Avenue and Pierce Mill Road, Washington, D. C.
  - Branch laboratories at—
    - Appraisers Building, San Francisco, Calif.
    - 434 Federal Building, Denver, Colo.
    - Lord Hall, Ohio State University, Columbus, Ohio.
    - Northampton, Pa.

Department of the Interior:
- Geological Survey, New Interior Building, Eighteenth and F Streets NW., Washington, D. C.

Navy Department:
- Aeronautical Engine laboratory, United States Aircraft Factory, Navy yard, Philadelphia, Pa.
- Bureau of Aeronautics, United States Naval Air Station, Anacostia, D. C.
- Bureau of Construction and Repair, Ninth Avenue and Martha Street, Munhall, Pa.
- Fire-control Laboratory, United States Navy yard, Washington, D. C.
- Fuel-oil Testing Plant, United States Navy yard, Philadelphia, Pa.
- Material Laboratory, United States Navy yard, Brooklyn, N. Y.
- Metallurgical and Testing Division, Navy yard, Washington, D. C.
- Naval Engineering Experiment Station, Annapolis, Md.
- Naval Medical Supply Depot, Sands and Pearl Streets, Brooklyn, N. Y.
- Naval Powder Factory, Indian Head, Md.
- Naval Research Laboratory, Bellevue, Anacostia, D. C.
- Naval Supply Depot, Twenty-ninth Street and Third Avenue, Brooklyn, N. Y.
- Navy yard, Boston, Mass.
- Navy yard, Mare Island, Calif.
- Navy yard, Norfolk, Va.
- Navy yard, Philadelphia, Pa.
- Navy yard, Puget Sound, Wash.

Treasury Department:
- Bureau of Engraving and Printing, Fourteenth and C Streets SW., Washington D. C.
- Bureau of the Public Health Service, Hygienic Laboratory, Twenty-fifth and E Streets NW., Washington, D. C.
- Division of Customs—
  - Customs laboratories—
    - Care United States appraiser of merchandise at—
      - 501 Lombard Street, Baltimore, Md.
      - 158 West Harrison Street, Chicago, Ill.
      - 408 Atlantic Avenue, Boston, Mass.
      - 423 Canal Street, New Orleans, La.
      - 641 Washington Street, New York, N. Y.
      - 134 South Second Street, Philadelphia, Pa.
      - Sansome and Washington Streets, San Francisco, Calif.

Treasury Department—Continued.
- Division of Customs—Continued.
  - Customs laboratories—Continued.
    - Care Collector of Customs, corner Bull and Dey Streets, Savannah, Ga.
  - Assay offices—
    - Care Deputy Collector of Customs, 915 Grant Avenue, Kansas City, Mo.
    - Care United States Appraiser of Merchandise, 641 Washington Street, New York, N. Y.
- Internal Revenue offices at—
  - 530 Post Office Building, Buffalo, N. Y.
  - Mint Building, Charlotte, N. C.
  - 428 Transportation Building, Chicago, Ill.
  - 36 West Gay Street, Columbus, Ohio.
  - 906 Waggoner Building, Fort Worth, Tex.
  - Transportation Building, Los Angeles, Calif.
  - 5 Federal Building, Minneapolis, Minn.
  - Customhouse, New Orleans, La.
  - 544 Old Post Office Building, New York, N. Y.
  - 317, Post Office Building (office), Omaha, Nebr.
  - 512 Earle Building, Philadelphia, Pa.
  - 601 House Building, Pittsburgh, Pa.
  - Federal Building, Providence, R. I.
  - 63 Appraisers Building, San Francisco, Calif.
  - Thompson Building, Seattle, Wash.
  - 1016 Title Guaranty Building, St. Louis, Mo.
  - 422 Treasury Building, Washington, D. C.
- United States Assay offices at—
  - Boise, Idaho.
  - Carson City, Nev.
  - Deadwood, S. Dak.
  - Helena, Mont.
  - 32 Wall Street, New York, N. Y.
  - Salt Lake City, Utah.
  - Seattle, Wash.
- United States Mint at—
  - Denver, Colo.
  - Philadelphia, Pa.
  - San Francisco, Calif.
- United States Coast Guard, Darby Building, 508 Fourteenth Street, Washington, D. C.

War Department:
- Air Corps, material division, Dayton, Ohio.
- Chemical Warfare Service, Edgewood Arsenal, Md.
- Medical Department at—
  - United States Army, Army Medical School, Army medical center, Washington, D. C.
  - United States Army, New York Intermediate Depot, Fifty-eighth and First Streets, Brooklyn, N. Y.
- Ordnance office, Watertown Arsenal, Dover, N. J.
- Quartermaster Intermediate Depot, Camp Holabird, Md.
- Quartermaster Intermediate Depot, Twenty-first and Oregon Avenue, Philadelphia, Pa.

War Department—Continued.

Quartermaster Subsistence School, 1819 West Pershing Road, Chicago, Ill.

Signal Corps—

United States Aircraft Radio Laboratory, McCook Field, Dayton, Ohio.

The Signal Corps Laboratory, 1800 Virginia Avenue NW., Washington, D. C.

Meteorological Laboratory, Room 3448, Munitions Building, Nineteenth and B Streets NW., Washington, D. C.

Subaqueous Sound Ranging Laboratory, Fort H. G. Wright, New London, Conn.

District Government:

Asphalt and Cement Laboratory, Room 527, District Building, Washington, D. C.

Government Printing Office, North Capitol and G Streets NW., Washington, D. C.

The Panama Canal, Munhall, Pa.

Smithsonian Institution, National Museum, the Mall, Washington, D. C.

United States Shipping Board Emergency Fleet Corporation, Pier No. 3, Hoboken, N. J.

United States Soldiers' Home, Washington, D. C.

United States Veterans' Bureau. (The Veterans' Bureau does laboratory work at the following Dispensaries and Hospitals:)

Dispensaries—

Class A—

Boston, Mass; New York, N. Y.; Philadelphia, Pa.; Pittsburgh, Pa.; Washington, D. C.; Atlanta, Ga.; New Orleans, La.; Cincinnati, Ohio; Chicago, Ill.; Detroit, Mich.; St. Louis, Mo.; Minneapolis, Minn.; Denver, Colo.; Los Angeles, Calif.; San Francisco, Calif.; Seattle, Wash.; Dallas, Tex.

Class B—

Newark, N. J.; Baltimore, Md.; Cleveland, Ohio; Louisville, Ky.; Indianapolis, Ind.; Milwaukee, Wis.; Des Moines, Iowa; Kansas City, Mo.; Omaha, Nebr.; Salt Lake City, Utah; Portland, Oreg.; Oklahoma City, Okla.; Little Rock, Ark.

Class C—

Albany, N. Y.; Hartford, Conn.; Charleston, W. Va.; Birmingham, Ala.; Jackson, Miss.; Lexington, Ky.; Wichita, Kans.; Sioux Falls, S. Dak.; Albuquerque, N. Mex.; Casper, Wyo.; San Antonio, Tex.

Hospitals—

Tuberculosis—

Alexandria, La.; West Haven, Conn.; Whipple, Ariz.; Tucson, Ariz.; Fort Bayard, N. Mex.; Oteen, N. C.; Camp Kearney, Calif.; Minneapolis, Minn.; Fort Harrison, Mont.; Outwood, Ky.; Fort Lyon, Colo.; Walla Walla, Wash.; Rutland Heights, Mass.; Legion, Tex.; Sunmount, N. Y.; Castle Point, N. Y.; Livermore, Calif.; Aspinwall, Pa.; San Fernando, Cuba.

Neuropsychiatric—

Palo Alto, Calif.; Perry Point, Md.; West Roxbury, Mass.; Philadelphia, Pa.; Knoxville, Iowa; Augusta, Ga.; Gulfport, Miss.; North Little Rock, Ark.; Bronx, N. Y.; Sheridan, Wyo.; American Lake, Wash.; Northampton, Mass.; Chillicothe, Ohio; Camp Custer, Mich.; St. Cloud, Minn.; North Chicago, Ill.

United States Veterans' Bureau—Continued.

Hospitals—Continued.

General—

Washington, D. C.; Waukesha, Wis.; Atlanta, Ga.; Boise, Idaho; Dwight, Ill.; Tacoma, Wash.; Lake City, Fla.; St. Paul, Minn.; Kansas City, Mo.; Fort Thomas, Ky.; Portland, Oreg.; Algiers La.; Memphis, Tenn.; Muskogee, Okla.; Tuskegee, Ala.; Jefferson Barracks, Mo.; Excelsior Springs, Mo.

VI. NATIONAL BUREAU OF STANDARDS

HISTORICAL OUTLINE [1]

The power to "fix the standard of weights and measures" vested in Congress by the Constitution (art. 1, sec. 8) was not exercised, except for coinage purposes, until the act of March 2, 1799, requiring semi-annual comparison of all the weights and measures used in the customhouses. However, this revision apparently was not enforced until 1830 when large discrepancies were found among the weights and measures in use by the customs collectors.

Without awaiting authority from Congress, a shop was equipped at Washington under the "Survey of the Coast," Treasury Department, for making new standards for customs purposes, copies of which, by act of Congress (1836), were sent to the States. The same office later supplied the governments of new States created by Congress. Congress also directed (1866) that the States be supplied with sets of metric standards. From 1873 funds were separately specified for this office, which was named (1883) the Office of Construction of Standard Weights and Measures.

The splendid work of the old office in establishing American standards and comparing them interested men of science. The International Electrical Congress (1884) held a special session to consider a paper on "A national bureau of physical standards"—the first call for such a bureau of science in America. The call was later echoed by the Secretary of the Treasury (1900), who proposed to Congress that such a bureau be established. "The enterprise," he stated, was "one of the most important branches of scientific work any Government was called upon to undertake" and that a scientific laboratory was called for "fitted for undertaking the most refined measurements known to modern science." The great technical and scientific societies joined the larger industries in support of the project.

In order to get into line with the other leading countries and to meet the demands of science and industry for standardization, the act of March 3, effective July 1, 1901, established the National Bureau of Standards, which was transferred from the Treasury Department to the Department of Commerce and Labor July 1, 1903.

At the time of organization, the National Bureau of Standards had only eight employees, including a watchman and a messenger. The

[1] For further reference see "Organization and Law of the Department of Commerce and Labor," Document No. 13; "History of the Standard Weights and Measures of the United States," by L. A. Fischer M 64; and "The Bureau of Standards," by G. A. Weber, published by the Institute for Government Research.

ensuing 25 years have brought about a steady conservative expansion of its primary functions until on July 1, 1926, the total staff numbered 785. Its library receives more than 600 technical and scientific journals and contains 27,000 catalogued books in several languages. Its 11 scientific and technical divisions cover more than 60 specialties.

FUNCTIONS

GENERAL

The National Bureau of Standards is charged by law with the custody of the standards; the comparison of the standards with those used in science, industry, technology, commerce, and educational institutions; the construction of standards and of their multiples and subdivisions; the testing and certification of standard measuring instruments; the solution of problems arising in connection with standards; the determination of physical constants and properties of materials; and other investigations authorized by Congress. The bureau's functions may be exercised for the National Government, State governments, and, subject to reasonable fees, the general public. The National Bureau of Standards aids industry directly or through cooperating committees to determine the best standards of dimension, quality, performance, and practice. Its unique research and testing facilities are used to discover and evaluate material standards, and to solve basic technical problems of industry.

STANDARDS OF MEASUREMENT

The bureau's work on standards of measurement is designed to aid accuracy in industry through uniform and correct measures. In this the bureau assists in size standardization of containers and products, in promoting systematic inspection of trade weights and measures to insure justice in daily trade, and finally to facilitate precise research in science and technology through the standardization of measuring instruments.

STANDARD CONSTANTS

The work of the bureau on the measured numerical data concerning material and energy; that is, standard constants, furnishes an exact basis for scientific experiment and design. These furnish also the data for the efficient technical control of industrial process.

STANDARDS OF QUALITY

The bureau's work on standards of quality includes the specification of the numerical magnitude of the property or group of properties which determine the quality. The purpose is to set an attainable standard of quality to assure high utility in the products of industry; to furnish a scientific basis for fair dealing by promoting truthful branding and advertising through suitable standards and

methods of test. This work yields large-scale economies by eliminating ineffective materials.

STANDARDS OF PERFORMANCE

The bureau likewise develops standards of performance; that is, specifications for the operative efficiency or accuracy of machines or devices. These are numerical statements of speed, uniformity, durability, output, economy, and other factors which, together, define the net efficiency of an appliance or machine. The ultimate purpose is to make exact knowledge the basis of the buyer's choice, to clarify the understanding between maker, seller, buyer, and user as to the operative efficiency of appliances and machines. An important outcome of this work is that it stimulates and measures mechanical progress.

STANDARDS OF PRACTICE

A function of the bureau of very general interest is the development of standards of practice; that is, collation of data and formulation of codes of practice for public utilities and other services. These are prepared in cooperation with the technical and commercial agencies concerned and relate to the technical regulation of construction, installation, and operation. They are necessarily based upon standards of measurement, standards of quality, and standards of performance. The purpose of such work is to afford a single impersonal standard of performance mutually agreed upon by all concerned and clearly defined in measurable terms. Incidentally, it insures effective design and installation of service utilities, and promotes safety, efficiency, and convenience in such service.

EXAMPLES

Congress has made special provision for research and testing in specific fields involved in the five kinds of standards described above. Some examples of such functions may be cited.

State Weights and Measures.—Aid to State governments on technical details of weights and measures inspection service, with a view to securing uniformity in weights and measures laws and methods of inspection.

Gauge Standardization.—Standardization and testing gauges, screw threads, and other length standards required in manufacturing.

Railroad Track Scales.—Investigation of track scales and other large scales used for interstate shipments and of large scales used by the Government in transactions with the public.

Mine Scales.—Investigating mine scales and the conditions and methods used to weigh and measure coal in fixing wages due, including investigations of all means for insuring accuracy in weighing and measuring at the mines.

High Temperatures.—Investigations of methods of high-temperature measurements and temperature control in various industrial processes, and making results available to industries.

Investigation of Automotive Engines.—For the promotion of economy and efficiency in automotive transportation by land and by air through investigations of the basic principles underlying the design, performance, operation, and testing of automotive engines, their fuels, lubricants, accessories, and the power-transmitting system used in connection with them, also such elements as brakes and brake linings; to promote economy in the use of liquid fuels and safety in vehicular traffic.

Color Standardization.—Development of color standards and methods of color measurement, with reference to their use in industrial color standardization, the specification of colorants and of products in which color is a pertinent property.

Radio Standardization.—Investigation and standardization of methods and instruments used in radio communication.

Sound Investigations.—Investigation of principles of sound and their application to military and industrial purposes.

Standard Analyzed Materials.—Preparation, analysis, and certification of the composition of technical materials, either of typical composition or of high purity, for use in checking and accuracy of scientific and industrial chemical analyses and for testing physical measuring instruments.

Fire-Resisting Properties.—Investigation of building materials and their efficient use, and standardization of types of appliances for fire prevention.

Structural Materials.—Investigation of stone, clays, cement, and other structural materials; the collation and dissemination of scientific and other information as to approved methods for building structural units; formulating building codes; and researches to promote, improve, and cheapen housing and other construction.

Other Industrial Materials.—Development of standards of quality and methods of measurement of textiles, paper, leather, and rubber. Tests of materials, such as varnish, soap, ink, and chemicals, including supplies for the Government service.

Clay Products.—Study of clay products, including methods of measurement and technical processes used in their manufacture; study of the properties of the materials used in this industry.

Optical Glass.—Investigation of problems involved in production of optical glass.

Metallurgical Research.—Researches in metals, including foundry practice, standards for metals, alloys, and sands; their properties and treatment; prevention of corrosion; development of substitutes for metals; behavior of bearing metals; preparation of specifications; investigation of new processes and methods of conservation in

manufacture; investigation of railway materials and causes of their failure.

Testing Machines.—Operation of testing machines in the determination of physical constants and properties of materials.

Sugar Standardization.—Development of technical specifications for all grades of sugars, involving their standardization and methods of manufacture; standardization and production of rare and unusual types of sugars for medical and other scientific uses; determination of fundamental scientific constants; standardization and design of sugar-testing apparatus; study of technical problems relating to collection of revenue on sugars; and practical use of results in tests of imported sugars.

Certification of Radioactive Materials.—Investigation of radium, radium compounds, and other radioactive materials; standard testing and certification of radioactive materials.

Standardization of Equipment.—Cooperation with the Government and with engineers and manufacturers in formulating standards of performance for instruments, equipment, tools, and other devices; the testing and inspection of the same; including formulation of methods of inspection and of laboratory and service tests to insure compliance with specification for quality and performance, and simplification of varieties of products.

Public Utility Standards.—Investigation of standards and solution of problems arising in connection with standards for public utilities, such as gas, electric light and power, water, telephone, heating, electric railway service.

Industrial Research.—Technical cooperation with the industries upon fundamental research to promote industrial development and to assist in the permanent establishment of new American industries.

Standardizing Mechanical Appliances.—To develop methods of testing and standardizing machines, motors, tools, measuring instruments, and other apparatus and devices used in mechanical, hydraulic, and aeronautic engineering; for the comparative study of types of apparatus and methods of operation, and for the establishment of standards of performance; for the accurate determination of fundamental physical constants involved in the proper execution of this work; and for scientific experiments and investigations needed in solving the problems which may arise in connection therewith, especially in response to the requirements of aeronautics and aviation for information of a purely scientific nature.

RELATION TO GOVERNMENTAL AGENCIES

FEDERAL

Measures have a vital place in Government. Coinage is based on weights derived from, and checked by, the troy pound of the National Bureau of Standards. The standard of length, the meter,

controls the invar steel tapes by which the master surveys are made and National and State boundaries fixed. The bureau's researches aid navigation, and the bureau sugar expert was assigned to modernize the sugar-testing methods at the ports and to place them upon a scientific basis. Duplicate samples of all sugar cargoes are now tested at the bureau to control port analyses. The bureau standardizes the water-current meters to measure stream flow in forecasting water supply and flood and drought in the national stream-gauging service. For all departments of the Government the bureau performs standardizing service for research apparatus measuring appliances and supplies and conducts joint researches. A special law enables the bureau to take up researches in which a given department is concerned, a transfer of funds being made upon approval of the heads of the two departments concerned. The advice of the bureau is sought by congressional committees, national committees and commissions, the Bureau of the Budget, the General Supply Committee, and almost all departments and independent establishments.

The director is ex officio chairman of the Federal Specifications Board and of the National Screw Thread Commission, which are largely dependent upon the bureau for investigational and office work. He is also a member of the National Advisory Committee for Aeronautics, the National Academy of Sciences, and the National Research Council.

STATE

The bureau aids the States to secure for their citizens full measure in shops and markets, adequate and safe public-utility service of electricity and gas, and efficient specifications for State supplies. The States depend upon the bureau for standards of measurement, for testing them at intervals to keep them true to the national standard. State officials confer at the bureau in a national conference on weights and measures held each year to discuss the technical details of local inspection, model laws, ordinances, and tolerances. The bureau's nation-wide survey awakened the States to the serious short measure prevalent in daily trade from defective measures, faulty measurements, or even fraud. Only two States had then adequate inspection. State legislatures and governors of States were apprised of the situation, and took effective action. To-day most of the States have efficient inspection based upon the model State law first drafted at the bureau and upon the manual of inspection practice prepared by the bureau.

A $4,000,000,000 freight bill is paid by the citizens of the States on products on their way to the people. The bureau's test cars traverse the various States on their nation-wide mission of accuracy, testing the master railroad track scales for the States. These, in

turn, insure accuracy in such weighings on devices which have shown notable improvement since this work was initiated.

The State purchasing officials requested the Department of Commerce to aid in the use of standard specifications for the purchase of materials and equipment. The National Directory of Commodity Specifications, compiled and published by the National Bureau of Standards with the cooperation of the Bureau of Foreign and Domestic Commerce, is for the joint benefit of State and Federal purchasing agencies.

Technical conferences of State utility commission engineers are held each year to promote cooperation of experts, State and National, in this field. Standardization problems are of vital concern in all regulation of public utilities.

The bureau is by law permitted to extend free testing service to State governments. This service covers weights, measures, measuring instruments, and materials, and is most useful. On request of the States of Pennsylvania and New Jersey the bureau tested full-sized members of the Philadelphia-Camden Bridge, using its 10,000,000-pound compression testing machine, the largest of its kind in the world.

MUNICIPAL

The bureau aids cities by expert advice on utilities, such as gas, electricity, or on technical inspection services, such as elevators, fire hazards, gas-using appliances, lightning protection, and building codes. The bureau developed a system of survey of the damage possible from stray electricity which destroys underground metal structures. Its remedial measures were completely worked out by the bureau and applied to a number of cities with its experts cooperating. The bureau's manual of weights and measures inspection gives the city inspectors their standard reference and instruction book—the "Manual of Inspection and Information for Weights and Measures Officials." This is compact, with useful data drawn from the nation-wide experience of bureau specialists, and is the inspector's most useful guide in his training and daily work.

The bureau aids city traffic management in several ways. It has devised automobile brake-testing methods, including a new decelerometer for measuring the rate of stopping. The methods have been demonstrated in testing campaigns in Washington. The bureau has tested and adjusted automobile headlight lamps, with excellent results to the car owners and road illumination. A publication giving the best lighting practice has just been issued and is being made the basis of city regulation.

The "Zoning Primer" explains the modern districting of cities. Housing publications on construction and on plumbing, and other

subjects described elsewhere, are aiding city governments in the intelligent promotion and regulation of city housing enterprises.

The bureau has encouraged and aided the establishment of municipal testing laboratories. Its service to the local government of the National Capital would form an interesting chapter touching on river pollution, water power, bridge testing by strain gauges, inspection of causes of fires and of building accidents, street lighting, theater curtains, testing of supplies, expert investigations in criminal cases, check tests of gas and electric meters, and the technical phases of traffic regulation and other distinctly city problems.

RELATION TO SCIENCE, COMMERCE, AND INDUSTRY

RESEARCH

Pure Science.—Research on problems arising in connection with standards is by act of Congress a primary work of the bureau. Research is essentially pioneer work. Progress demands new kinds of measurements, new standards, and ever-increasing accuracy. Close cooperation with other organizations interested in pure science encourages the free exchange of discoveries customary in this field and frequently provides corroboratory bases for new hypotheses. The bureau conducts hundreds of researches and suggests industrial applications for the results.

Research Associates.—Much of the bureau's research is directed to the application of science in commerce and industry. The research associate [2] plan permits industrial associations or groups to place qualified men at the bureau for intensive study of selected problems approved by the Director of the National Bureau of Standards. Such men utilize the bureau's laboratory facilities and equipment and have the same status as any bureau employee except that their salaries are paid by the supporting group or association.

The work of a research associate is one of peculiar trust on problems of concern to an entire industry. Research results are immediately available to the industry concerned and are frequently printed in bureau publications. Devices or processes developed during research may not be patented for the benefit of the individual or the group, but are for the free use of the industry, the Government, and the public. Correspondence relating to the work of the research associate is conducted through official channels except on purely personal matters.

A list of the research associates and projects under investigation arranged according to sustaining organizations is given in the following table. Current work of research associates relating to standards of quality, performance, or practice, is given under activities and accomplishments.

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[2] For further details, see B. S. Circular No. 296.

Research associates

Assigned by—	General field research	Specific project	Research associate
Academy of Science for Engineers, Stockholm, Sweden	Metallurgy	Gases in metals	Kjerrman, Bengt.
American Association of Textile Chemists and Colorists, W. E. Hadley, secretary, care of Clark Thread Co., Newark, N. J.	Textiles	Assisting in study of methods for testing fastness to light of dyed fabrics.	Fleischer, Edith.
American Bureau of Welding, 29 West Thirty-ninth Street, New York, N. Y. American Electric Railway Association, 292 Madison Avenue, New York, N. Y., committee on welded rail joints.	Railway materials	Welded rail joints	Olsson, E.
American Face Brick Association, 130 North Wells Street, Chicago, Ill.	Structural materials	Prevention of stain on brick structures	Palmer, L. A.
American Gas Association, 342 Madison Avenue, New York, N. Y.	Gas engineering	Methods of testing gas appliances to determine their safety.	Heywood, R. W.
American Rolling Mill Co., Middletown, Ohio	Metallurgy	Corrosion of zinc-coated iron	Cain, J. R.
American Scandinavian Foundation, 25 West Forty-fifth Street, New York, N. Y.	do	Metallographic work; investigation of the structure of iron.	Berglund, T.
American Society of Mechanical Engineers, 29 West Thirty-ninth Street, New York, N. Y.	High-temperature measurements.	Steam tables	Osborne, N. S.; Stimson, H. F.
Asphalt Shingle and Roofing Association, 285 Madison Avenue, New York, N. Y.	Structural materials	Relative value of different fibers used in roofing felt.	Strieter, O. G.
Associated Knit Underwear Manufacturers of America (Inc.), 329 Main Street, Utica, N. Y.	Textiles	Standardization and simplification of underwear sizes.	Hamlin, C. H.
Atlas Lumnite Cement Co., 25 Broadway, New York, N. Y.	Structural materials	Properties of high alumina cement	Evans, J. C.; Rapp, Paul.
Banner Rock Products Co., Alexandria, Ind	Heat transfer	Thermal conductivity at high temperature	Semple, H. S.
Breit, G	Optics	Experiments in scattering of gamma rays in radioactivity.	Breit, G.
Bureau of Efficiency, Washington, D. C	Paper	Durability of currency paper	Gottschalk, V. H.; Worthington, V.
Celite, Products Co., Los Angeles, Calif	Structural materials	Workability of concrete	Conahey, G.; Smith, G. A.
Celotex Co., 645 North Michigan Boulevard, Chicago, Ill	Heat transfer	Heat transmission of materials	Schmidt, Lawrence D.
Chicago Bearing Metal Co., 2234 West Forty-third Street, Chicago, Ill.	Metallurgy	Bearing metals	Harbaugh, W. L.
Common Brick Manufacturers Association of America, 2121 Guarantee Title Building, Cleveland, Ohio.	Structural materials	Compression tests on brick walls	McBurney, J. W.; Abbott, G. M.
Copper and Brass Research Association, 25 Broadway, New York, N. Y.	do	Investigation of safe loading of corrugated copper roofing, etc.	Beij, K. H.; Lankford, J. W.
Eichlin, C. G	Optics	Glass; glass heat treatment	Eichlin, C. G.
Elevator Safety Code Committee, subcommittee on research, approval, and interpretation, American Engineering Standards Committee, 29 West Thirty-ninth Street, New York, N. Y.	Safety engineering	Elevator safety equipment development of instruments and methods; construction, maintenance, operation, etc.	Dickinson, J. A.; Burnham, J. H.
Gathman Engineering Co., Garrett Building, Baltimore, Md	Metallurgy	Sound steel ingots	Dowdell, R. L.
Golwynne, Henry A., 26 Cortlandt Street, New York, N. Y	Ceramics	Cyanite in the manufacture of superrefractories.	Freed, M. L.
Gypsum Industries, 844 Rush Street, Chicago, Ill	Sound	Acoustical properties of building materials	Chrisler, V. L.
	Structural materials	Gypsum	Dalley, M. C.
Hollow Building Tile Association, Conway Building, Chicago, Ill	Fire resistance	Fire resistance of hollow clay tile	Campbell, A. J.; Foster, H. D.
Horological Institute of America, Academy of Sciences Building, Washington, D. C.	Time measurements	Certification of watchmakers	Miller, M. M.
Indiana Limestone Quarrymen's Association, Bedford, Ind	Structural materials	Properties of Indiana limestone, including waterproofing, discoloring, etc.	Dutton, H. H.
International Association of Electrotypers of America, H. G. Guiteras, secretary, Leader Building, Cleveland, Ohio.	Electrotyping	Nickel electrotyping	Winkler, J. H.

Research associates—Continued

Assigned by—	General field research	Specific project	Research associate
International Nickel Co., 67 Wall Street, New York, N. Y.	Metallurgy	Gases in metals	Geiger, G. F.
Molybdenum Co. of America, 61 Broadway, New York, N. Y.	Chemistry	Use of molybdic acid in preparation of color lakes from basic dyes.	Stewart, John R.
Munsell Research Laboratory, 10 East Franklin Street, Baltimore, Md.	Colorimetry	Hue discrimination, saturation and purity of colors.	Greenberg, William; Judd, D. B.; Linke, R. N.; Riley, J. O.; Tyndall, E. P. T.; Faling, M. F.; Goldman, M. H.; Hubbard, C. C.
National Association of Dyers and Cleaners, 807 Mills Building, Washington, D. C.	Dyeing and cleaning	Cleaning weighted silk as affected by cleaning solvents and perspiration, and general cleaning and dyeing problems.	
National Association of Hosiery and Underwear Manufacturers, 334 Fourth Avenue, New York, N. Y.	Textiles	Moisture content of carded and combed yarns; standardization of twist with respect to dye application.	Schenke, E. M.
National Association of Marble Dealers, Rockefeller Building, Cleveland, Ohio.	Structural materials	Use and care of marble for interior installations.	Kessler, D. W.
National Carbon Co., 30 East Forty-second Street, New York, N. Y.	Optics	Radiation from carbon arcs	Dorcas, M. J.
National Association of Glue Manufacturers, J. R. Powell, secretary, care of Armour Glue Works, 1355 West Thirty-first Street, Chicago, Ill.	Adhesives and coating of papers.	Glue for use in paper sizing	Hamill, G. K.; White, W. E.
National Knitted Outerwear Association, 347 Fifth Avenue, New York, N. Y.	Textiles	Methods of measuring outer-wear garments	McGowan, F. R.
National Lime Association, 918 G Street, Washington, D. C.	Structural materials	Development of quick-setting lime plaster	Bury, P. A.
National Slag Association, 933 Leader Building, Cleveland, Ohio	do	Properties of blast-furnace slag	Muskopf, M. A.
National Research Council, Washington, D. C.	Optics	Fine structure of spectrum lines	MacNair, W. A.
National Terra Cotta Society, 19 West Forty-fourth Street, New York, N. Y.	Structural materials	Investigation of architectural terra cotta	Fuller, D. H.; Klinefelter, T. A.; Schurecht, H. G.
Portland Cement Association, 111 West Washington Street, Chicago, Ill.	do	Constitution and hardening of Portland cement.	Ashton, F. W.; Bogue, R. H.; Brownmiller, L. T.; Dillon, M. M.; Hansen, W. C.; Harrington, E. A.; Lerch, W.; Taylor, W. C.
Research Service (Inc.), 810 Eighteenth Street NW., Washington, D. C.	do	Compression tests of interlocking tile	Pisarra, A. M.
Shaw, H. S., jr. (through National Research Council)	Radio	Radio wave phenomena	Parkinson, T.
Society of Automotive Engineers, 29 West Thirty-ninth Street, New York, N. Y.	Automotive research (operating through joint steering committee).	Research on fuels	Eisinger, J. O.; Ritchie, D. C.; Ragsdale, W. F.
American Petroleum Institute, 250 Park Avenue, New York, N. Y.			
National Automobile Chamber of Commerce, 366 Madison Avenue, New York, N. Y.			
Spanish Artillery Academy, Segovia, Spain	Metallurgy	Pearlitic cast iron	Soto, A. G.
The Commonwealth Fund, 1 East Fifty-seventh Street, New York, N. Y.	Carbohydrates	Chemistry of carbohydrates	Purves, C. B.
Weinstein Research Laboratories, 233 West Forty-second Street, New York, N. Y.	Dental research	Physical properties of dental materials	Coleman, R. L., jr.; Poppe, W. A.

Coordination with Other Research Laboratories.—With the aid of the National Research Council, the A. S. T. M. Committee E–9 on Correlation of Research, the various research laboratories, and many national organizations every effort is made to coordinate all bureau research work with that done by other bodies to provide the maximum national benefit and to avoid duplication of effort.

Research within the Government service is coordinated by the Chief Coordinator of the Bureau of the Budget.

ADVISORY COMMITTEES

Where a group interested in the formulation of standards for a given industry or in the investigation of specific subjects are not otherwise organized for the purpose the bureau encourages the formation of an advisory committee. These committees function much the same as an informal industrial committee except that the secretarial work is usually conducted by the bureau.

Advisory committees

Name	Purpose	Secretary	Membership
Building Code Committee.	To formulate and recommend provisions for municipal building code regulations.	George N. Thompson, division of building and housing, Commerce Department, Washington, D. C.	Eight outstanding architects and engineers.
Advisory Committee on Cement.	To advise on work on the constitution and hardening of Portland cement.	George E. Warren, Portland Cement Association, 33 West Grand Avenue, Chicago, Ill.	Committees of Portland Cement Association and American Society of Civil Engineers.
Advisory Committee on Ceramics.	To assist in outlining proposed investigations and reviewing results obtained.	A. V. Bleininger (chairman), Homer Laughlin China Co., Newell, W. Va.	Ceramic associations, brick associations, and tile associations.
Advisory Committee on Cotton.	To advise on technical questions dealing with cotton.	R. T. Fisher, 80 Federal Street, Boston, Mass.	Manufacturers of cotton textiles.
Advisory Committee on Cordage.	To advise on technical questions dealing with cordage.	J. S. McDaniel (chairman), 350 Madison Avenue, New York, N. Y.	Cordage Institute.
Committee on Arch Dam Investigation.	In charge of construction and testing of arch dam in California 60 feet in height.	Fred A. Noetzli, 928 Central Building, Los Angeles, Calif.	Consulting and professional engineers.
Joint Steering Committee on Cooperative Fuel Research.	To assist in formulating program and defining scope of investigations in connection with cooperative fuel research.	None. Care of Society of Automotive Engineers, 29 West Thirty-ninth Street, New York, N. Y.	Society of Automotive Engineers.
Gauge Steel Committee	To carry on research on dimensional changes in hardening, tempering, and aging of gauges.	H. W. Bearce, Bureau of Standards, Washington, D. C.	Manufacturers of steel, manufacturers and users of gauges, United States Army Ordnance Department and National Bureau of Standards.
Advisory Committee on Gypsum.	To review and criticize work of The Gypsum Industries.	H. J. Schweim, The Gypsum Industries, 844 Rush Street, Chicago, Ill.	Technical problems committee of The Gypsum Industries.
Advisory Committee on Standardization of Builders' Hardware.	To standardize finishes, nomenclature, definitions, types, and general practices affecting builders' hardware.	I. J. Fairchild, National Bureau of Standards, Washington, D. C.	All manufacturers of builders' hardware.
Advisory Committee on Leather.	To advise on technical questions dealing with leather.	T. Blackadder (chairman), Bridesburg, Pa.	Leather manufacturers.

Advisory committees—Continued

Name	Purpose	Secretary	Membership
Standard State Mechanics' Lien Act Committee.	To draft a uniform mechanics' lien act for consideration by State legislatures.	Dan H. Wheeler, division of building and housing, Department of Commerce, Washington, D. C.	Architects, lawyers, credit men, and associations connected with building or construction operations.
Ferrous Metals Advisory Committee.	To guide bureau in selection of research problems in ferrous metals.	Prof. G. B. Waterhouse, (chairman), Massachusetts Institute of Technology, Cambridge, Mass.	A. S. T. M., associations of automotive, mining, and metallurgical engineers and foundrymen, and American Society for Steel Treating.
Nonferrous Metals Advisory Committee.	To guide bureau in selection of research problems on nonferrous metals.	W. M. Corse, Investment Building, Washington, D. C.	A. S. T. M., Government departments, and associations of electrochemical, mechanical, mining, and metallurgical engineers.
Subcommittee on Plumbing.	To formulate and recommend provisions for State and municipal regulation of plumbing installations.	George N. Thompson, division of building and housing, Department of Commerce, Washington, D. C.	7 sanitary engineers.
Manufacturers Advisory Committee on Vitreous China Plumbing Fixtures.	To standardize nomenclature, definitions, grading rules, essential dimensions and types of vitreous china plumbing fixtures.	I. J. Fairchild, National Bureau of Standards, Washington, D. C.	All manufacturers of vitreous china plumbing fixtures.
Radio Advisory Committee.	To assist in formulating and revising program of research in radio communication.	J. H. Dellinger, National Bureau of Standards, Washington, D. C.	Associations of radio engineers, electrical engineers, broadcasters, radio and electrical manufacturers.
Committee on Program on Transverse Fissures in Rails.	To study the causes of segregation of rails.	J. R. Freeman, jr., National Bureau of Standards, Washington, D. C.	Associations of civil and railway engineers and rail manufacturers.
Committee on Properties of Steam and the Extension of the Steam Table.	To direct research on the properties of steam and the extension of the steam table.	George A. Orrok (chairman), 17 Battery Place New York, N. Y.	American Society of Mechanical Engineers.
Advisory Committee on Structures and Fabricated Metals.	The development of apparatus and methods of test to obtain data for correlation of properties of material with behavior of the structure under load.	J. H. Nelson (chairman), Wyman-Gordon Co., Worcester, Mass.	Government departments, engineering societies, steel manufacturers, shipbuilding corporations, engineers, and college professors.
Advisory Committee on Tanning.	To advise on technical questions dealing with the tanning of leather.	J. W. Byron, Williamsport, Md.	Tanners Council of America.
Advisory Committee on Hollow Tile Investigation.	To assist in formulating program and defining scope of the researches on the properties of clay hollow tile.	J. T. Howington (chairman), Coral Ridge Clay Products Co., Louisville, Ky.	Hollow Building Tile Association.
Advisory Committee on Wool.	To advise on technical questions dealing with wool.	Walter Humphreys, 80 Federal Street, Boston, Mass.	Manufacturers of wool textiles.
Advisory Committee on City Planning and Zoning.	To encourage proper city planning and zoning by drafting standard State enabling acts under which municipalities may take action, and through other publications.	James Spear Taylor, division of building and housing, Department of Commerce, Washington, D. C.	10 engineers, lawyers, realtors, and housing experts.

COOPERATING ORGANIZATIONS

Many national organizations assist the bureau in research, standardization, and simplification projects and, in turn, the bureau cooperates officially with numerous national organizations engaged in similar effort, frequently designating members of the staff to serve on committees.

PUBLICATIONS

New research results or discoveries are announced in printed bureau publications. Nearly 1,350 pamphlets have been published to date. Releases to the daily press give briefly the outstanding news of the bureau's activities. Technical abstracts are prepared for dissemination to the technical journals. New knowledge of general or pure science is published in "Scientific Papers." Results of direct application in the industries are printed as "Technologic Papers." These two series are bound in volumes of approximately 750 pages. About 18 volumes have been issued of each series. Compiled technical or administrative matter is issued as a "Circular;" for example, the standard gasoline tables, test schedules, tests, specifications, and the like. Codes and reference texts; for example, the codes of electrical, gas, and logging practice, which must be carried about by the expert in his daily work, are issued as "Handbooks." This series is of pocket size.

The program for the simplification of commercial practice leads to definite proposals known as "Simplified Practice Recommendations." Charts, conference reports, and material not suitable for other series are published as "Miscellaneous Publications."

The bureau's Technical News Bulletin is a monthly periodical giving items concerning pending or completed work of the bureau. The bureau also prepares "letter circulars" on specialized subjects for use as replies to inquiries by mail. The 221 letter circulars prepared to date cover a wide range of subjects and represent material not yet ready to be included in the printed series. In addition to the Government publications, papers on subjects within the respective specialties are printed in outside journals.

Bureau publications are sold by the Superintendent of Documents. Subscriptions may be placed in advance for the Scientific Papers and for the Technologic Papers. The bureau issues a descriptive list (Circular 24, together with annual supplement) of its published material. Announcement cards giving titles of all new publications are sent regularly on request to those concerned with the bureau's work.

RELATION TO OTHER TESTING LABORATORIES

FEDERAL TESTING LABORATORIES

Several departments of the Federal Government have established laboratories for special testing work where required by the nature or number of tests. When specific investigations are under way the work is frequently divided and coordinated among several Federal laboratories. A list of such laboratories is given on page 144.

SOME ACTIVITIES AND ACCOMPLISHMENTS

GENERAL

All activities of the bureau concern some phase of standardization, from the pursuit of information on which to measure or base standards to the final check of delivered material for conformity to standards. The relation of some branches of the work to standardization may be obscure to the uninitiated.

Precise measurement of light waves of the rays characteristic of the chemical elements with an error of less than 1/254,000,000,000 inch has aided standardization in many ways. One result is the analysis of materials to detect minute traces of impurities with a successful application in control of steam boiler fuse plugs whose perfect functioning depends upon high purity. The interference of such waves permitted unsurpassed accuracy in ruling line standards, so that one gauge maker[3] reports: "These scales (twelve 6-inch scales) are a source of immense satisfaction to us. The accuracy with which they were done has obviated the continual series of calculations that are always in evidence when there are variations in the graduations" and describes the work as "a method that will help all industry that has occasion to get practically perfect master standards."

ELECTRICAL

Maintenance of Fundamental Electrical Units.—The two electrical units defined as fundamental in the international system are the ohm, as reproduced by specified columns of mercury, and the ampere, as defined by the silver voltameter. In practice, however, the units are maintained over considerable periods by wire resistance standards for the ohm and by standard cells for the volt in lieu of a standard for the ampere. The accepted value (1.0183 volts) for the Weston normal cell was established by an international committee working at the bureau in 1910. Since that time the ohm has been maintained at the bureau by assuming that the mean resistance of a group of selected 1-ohm wire standards remains constant. About 30 such standards are kept under observation, but for any one period between intercomparisons 10 which have shown the best degree of consistency are taken as the basis for measurements. In a somewhat similar way the volt is maintained by several groups of standard cells. The one mercury ohm determination and the few groups of cells made since 1910 have been considered as corroborating within their limits of certainty the values of the units as thus maintained. Several comparisons with other national laboratories have likewise indicated that the units are consistent within about 2 parts in 100,000. It is, however, now quite certain that the inter-

[3] Brown & Sharpe Manufacturing Co., May 28, 1924.

national ohm differs from the true or absolute ohm by about 5 parts in 10,000.

In view of the long period over which the units have been maintained at the bureau by means of secondary standards (coils and cells) it would be highly desirable to check their values by new mercury ohm and silver voltameter determinations. Nevertheless it has been believed that a revival of the researches on absolute units is still more important and that if successfully carried out these researches would, in effect, give also as accurate a check on the international units as could be made by the use of the mercury column and voltameter. Since it has not been practicable to take up work on both types of standards, attention has been given first to the development of apparatus for establishing the absolute units. Priority has been given to the ohm because the bureau has never made any determinations of its value. Two independent schemes for accomplishing this purpose are being developed. Both will use stationary inductance coils designed for calculation of the inductance from dimensions. One method will use mutual inductances so arranged that the electromotive force induced in the secondaries can be balanced against the drop in potential in a resistance of which the value is to be determined. The other procedure is planned to make use of the experience of the Inductance Laboratory. It will consist essentially of the comparison, by alternating-current bridge methods, of a self-inductance of calculated value with a resistance to be measured. In each project it is desired to carry the results to an accuracy approaching 1 part in 100,000, and this requires a theoretical and experimental study of many details which are neglected in ordinary measurements. Fair progress is being made, but it is impossible to predict when final results will be obtained.

For current measurements, the balance used by Dr. E. B. Rosa and his associates is now being reassembled and studied for possible improvements. It is hoped that this will soon give results, which, in conjunction with the wire ohm standards, will serve to check the bureau's standard cell values.

Standard Cells.—The unit of voltage is now maintained at the bureau first by a primary reference group of 20 cells in an oil bath thermostatically controlled, and, secondly, by two other reference groups, one of which is stored in the vault with other primary standards of the bureau, the third group being kept in the section office. Intercomparisons of the primary reference group with the two secondary groups made during the year, show variations on the average of only 1 to 4 microvolts. Two mercury stills have been installed in the chemical laboratory, especially equipped for the preparation of pure materials. New materials have been prepared for standard cells, and six new cells, the first made at the National Bureau of Standards

36316—27——12

since July, 1916, were prepared. These cells gave a voltage agreeing within 12 microvolts with the standard value as determined by the primary reference group. There has been a great increase in the standard cell testing. During six months of the year 1926 more cells were received for test and certification than were tested and certified by the bureau altogether during the first nine years of its existence. Analysis of standard cell records extending over a number of years have been made to determine the annual average decrease in voltage of the unsaturated form of cell. Since this has been found to be larger than was anticipated, it is apparent that a circular of general information on standard cells for commercial use would be of value. Such a circular has been in preparation. A new form of certificate to include such general information as is desirable for the users of standard cells has also been prepared to replace the form of certificate previously in use. Intercomparisons of standard cells with England and Japan have been made during the year, and a group of standard cells was tested and certified for Russia.

Determination of the Henry in Terms of Mechanical Units.—The absolute determination of the henry is based on the construction of a coil whose inductance can be computed from its dimensions. This problem can then be separated into four parts: (1) The construction of an inductance of such a form that its dimensions can be accurately determined, (2) the measurement of the mechanical dimensions of the inductance, (3) the derivation of a formula by which the inductance can be computed, (4) the measurement of the inductance in terms of the international electrical units. The best form of an inductance for this work is a single-layer solenoid. The following discussion is based on this type of inductance.

(1) The Construction of an Accurate Solenoid.—A porcelain tube 20 inches long and 12 inches in diameter was ground so that the outer surface was cylindrical. When removed from the grinding machine the variation from a true circular cross section was small. The dimensions at the two ends were also nearly identical. This cylindrical surface was then wound in a precision lathe with specially drawn round wire. Measurements made after this winding showed that the diameter in the center where the tension of the wire was greatest was appreciably less than that at the ends. Moreover, as the porcelain was not of the same thickness throughout, the compression changed slightly the form of the cylinder so that it was no longer exactly circular. However, it is believed that a mean of a large number of measurements will give a value which is sufficiently accurate. A second cylinder has been constructed using wire of rectangular cross section, but no measurements have been made upon it.

(2) The Measurement of the Mechanical Dimensions of the Inductance.—It is necessary to make three separate measurements: (*a*) The diameter of the wire, (*b*) the diameter of the cylinder, and (*c*) the mean pitch of the winding.

The diameter of the wire can be measured with sufficient accuracy by means of a good micrometer. No special apparatus was, therefore, required. The diameter of the cylinder must be measured with great accuracy and under the same conditions as used in making the electrical measurements. Therefore, a special micrometer has been constructed by means of which the diameter can be measured in a constant temperature chamber. A description of this micrometer has been published in the Journal of the Optical Society of America and Review of Scientific Instruments, Volume 11, No. 4, October, 1925, entitled "An Electrically Controlled Micrometer Caliper," by Dr. Charles Moon. The mean pitch can be determined by measuring the over-all length of the winding and dividing it by the number of turns. To measure the over-all length a special flotation cathetometer has been devised. A description of this will soon be published.

(3) Derivation of an Inductance Formula for a Solenoid.—While formulas for the inductance of a solenoid were available, they had all been derived on the assumption that the winding was of round wire and that it consisted of a series of circles. In order to compute the inductances of various solenoids on which work is being done, it was necessary to derive a more general formula. This has been done and is published in Scientific Paper No. 537, entitled "A Formula for the Inductance of a Helix Made with Wire of Any Section," by Dr. Chester Snow. A formula has been developed which will hold for wire of any shape of cross section when wound on a solenoid in the form of a helix.

(4) The Measurement of Inductance in Terms of International Electrical Units.—This consists first in the absolute measurement of capacitance and then in the measurement of the inductance in terms of this capacitance. The absolute measurement of capacitance of large air condensers has presented a number of new problems for investigation. One of the most accurate methods of measurement is by the Maxwell absolute capacitance bridge in which a portion of the electricity which charges a condenser passes through the galvanometer in one direction while a steady current through resistances flows through the galvanometer in the opposite direction. When the resistances have been properly adjusted the galvanometer makes a small oscillation about its zero position. The theory of this method has been carefully studied. It is now possible to measure the value of a 0.1 microfarad condenser with an accuracy of 1 part in 100,000. A brief description of some of the

theoretical problems connected with this bridge was given in a paper by H. L. Curtis and C. Moon, "A ballistic galvanometer as an integrating instrument," before the April meeting of the American Physical Society. A more complete paper will soon be published.

Absolute Measurement of High Voltages.—A large absolute electrometer has been under construction, and is nearing completion. It is based on the principle of the Kelvin attracted-disk electrometer, but differs from previous instruments of this kind in its much greater dimensions and in having a new system of guarding the electrostatic field between the plates. The nominal range of voltage measurement with this instrument is from 5,000 to 250,000 volts. It will thus more than cover all voltages used at present in the transmission of power. The estimated precision of observation is about 1 part in 10,000, and it is hoped to obtain an accuracy of 5 parts in 10,000 or better. In the design and construction of this instrument no pains or expense have been spared to obtain the most suitable materials and to incorporate all the refinements which will add to the accuracy and dependability of the measurements.

Electrical Properties of Rubber and Gutta-Percha.—The investigation of electrical insulating materials begun some years ago with particular reference to insulation of submarine cables has been continued on broader grounds. Technologic Paper No. 299, "Dielectric constant, power factor, and resistivity of rubber and gutta-percha," by H. L. Curtis and A. T. McPherson, issued in 1925, covered work on rubber compounds having less than 8 per cent of sulphur. The work has since been extended to determine the variation of electrical constants with composition over a wider range. Rubber sulphur compounds can be made which will have any percentage of combined sulphur from 0 to 32 per cent. A small proportion of sulphur produces the ordinary soft rubber of commerce, whereas a high percentage of sulphur gives the well-known hard rubber. Between these two there is a region in which the properties are very little known. This study of rubber sulphur compounds has included not only the measurement of the dielectric constant, power factor, resistivity, and dielectric strength, but also the density and water absorption. Moreover the first three of the above electrical properties have been determined for various hydrostatic pressures up to 10,000 pounds per square inch.

Magnetic Measurements on Sheet Steel.—Sheet steel, known to the trade as electrical sheet, constitutes a large percentage of the magnetic materials used in the manufacture of electrical machinery and apparatus. In order to promote uniformity in the specification and testing of this type of material, an investigation has been carried out for determination of the methods and procedure which will yield the most consistent and representative results. The results

of this investigation are given in a scientific paper, "The determination of the magnetic induction in sheet steel," by R. L. Sanford and J. M. Barry.

Magnetic Reluctivity Relationship.—The magnetic reluctivity relationship showing a linear relationship between magnetic reluctivity and magnetizing force has been used to quite an extent for the interpretation of data on the correlation between magnetic properties and other physical properties. In view of the fact that the validity of this relationship has recently been questioned, and investigation was carried out which resulted in the conclusion that the criticism was well founded and that the linear law is not valid. A new relationship was worked out which appears to represent the facts fairly well. More precise methods of test must be developed before the exact law can be determined. This work is described in a Scientific Paper, "The Magnetic Reluctivity Relationship," by R. L. Sanford.

Standardization of Storage Batteries.—The bureau is taking active part in the standardization of storage batteries, but this is mainly in cooperation with other organizations. With the Society of Automotive Engineers, the bureau has participated in work involving the standardization of sizes and ratings for automobile batteries and bus batteries. A standard nomenclature for automobile batteries has been prepared and, with minor revisions, this has been adopted by the Society of Automotive Engineers. The bureau is also cooperating with the American Institute of Electrical Engineers in the revision of their standards for storage batteries. This relates to standard definitions and nomenclature rather than to any particular size or type of battery. The bureau is also cooperating with the American Electrochemical Society which has a standing committee on these batteries.

Testing of Dry Cells.—Tests have been conducted for many bureaus and departments of the Government on a wide variety of dry cells, including those for flashlight batteries, telephone, ignition, radio, and other uses. In accordance with Bulletin No. 36 issued by the Chief Coordinator, Bureau of the Budget, both qualification and acceptance tests are recognized. The qualification tests are to determine the relative standing of various brands of dry cells and batteries when subjected to intermittent and delayed service tests as specified in Federal Specifications Board specification No. 58. Acceptance and inspection tests are also made on batteries delivered by contractors to determine whether they comply with the requirements of the specifications. The qualification tests are made on batteries taken by bureau inspectors from the product of manufacturers who have expressed a willingness to cooperate with the bureau. The results of such tests are made available for the use of various departments of the Government, and each manufacturer is informed of the results

of these tests on his own product. A qualification test was made in 1925 and completed within a period of about nine months. Because of the large number of manufacturers wishing to participate in this test, it became apparent that the bureau must enlarge its testing facilities. The 1926 qualification test was, therefore, deferred until the latter part of the year, and a new testing equipment was installed to accommodate approximately four times the number of dry cells and batteries which could be handled by the old equipment.

The central feature of the equipment is a switchboard of the telephone type for reading the cell voltages, many of which have to be read and recorded within a minimum space of time. The wiring includes more than a thousand circuits calibrated and adjusted to proper values of resistance for the various tests. On the 1926 qualification test 20 manufacturers have submitted samples of their product, and the test has been begun in accordance with the regular schedule.

Improvements in Measurement of Radio-Frequency.—One of the major developments in the bureau's radio work has been the improvement of frequency measurement. The general aim has been to give the bureau's standards and measurements an ample margin of accuracy over the present requirements of frequency control for radio transmitting stations. This calls for an accuracy considerably better than 0.1 per cent, which is far better than that obtainable in frequency measurements a year or two ago. This increase in accuracy has been accomplished through improvements in the primary standards of frequency and in the method of establishing the radio-frequency values.

A harmonic amplifier was developed by which very accurate and rapid measurements of radio-frequencies can be made in terms of an audio-frequency such as that furnished by a tuning-fork generator. This method was used to provide new calibrations for the frequency meters of the laboratory and for a number of quartz plates as fixed frequency standards. To standardize the quartz plates a sonometer was used as an auxiliary device for measuring small frequency differences. The laboratory's frequency standards were thus established to a higher accuracy than ever before for the whole range from 1 to 30,000 kilocycles per second. This work is described in "Establishment of radio standards of frequency by the use of a harmonic amplifier," by C. B. Jolliffe and Grace Hazen.

Piezoelectric quartz plates were found to serve very effectively as standards of frequeney and as auxiliary calibrating devices. A paper describing the technique of their preparation and pointing out their manifold usefulness, with the title "Uses and possibilities of piezo oscillators" was prepared by A. Hund, and has been published in the Proceedings of the Institute of Radio Engineers Volume 14, page 447; August, 1926. The piezo oscillator was developed for

use as a frequency indicator, which gives a readily available and extremely convenient standard of frequency for use in transmitting stations. A piezo oscillator and auxiliary generator were designed for the use of the radio inspectors of the Bureau of Navigation. Specifications were prepared for these devices, and the bureau completed the construction and calibrated 12 sets of these instruments.

A number of improvements were made in frequency meters, particularly in the condenser construction. A study was made of the resistance of the windings of the coils for standard frequency meters throughout the frequency range 150 to 6,000 kilocycles per second.

An international comparison of frequency standards was made by sending two piezo electric oscillators to the national laboratories of England, France, Germany, and Italy. Preliminary results indicate that the several laboratories are in very good agreement.

Radio Wave Intensity Measurements.—The dependence of progress in radio upon further knowledge of the vagaries of radio-wave transmission has led the bureau to make a study of the measurement of radio-wave intensity. Measurements were made on the field intensities of the waves received from various broadcasting stations. The received waves not only exhibit the well-known phenomenon of fading, but there is also a surprising variation in the average field intensities received at night.

It was found that the actual radiating ability of a transmitting station can not be determined either from the power used or the antenna current, but is most accurately found by measurements of the field intensity of the radiated waves. Such measurements must be made at distances of 50 miles or less so as to avoid the errors introduced by fading and must be made at a number of points in various directions around the station in order to be highly accurate. The importance of measurements of this kind has been increasingly felt in the radio-inspection service, and the National Bureau of Standards was asked to design a portable instrument for measuring field intensities of broadcasting stations. Such a set was designed, constructed, and tried under conditions of use on the field car of the radio inspection service. After trials, the set was redesigned and purchase specifications for additional sets were prepared.

A study of the effects of high-power broadcasting was made in cooperation with station WGY. Special transmissions were arranged in which 50 and 2½ kilowatts were used alternately. A large group of cooperating observers were requested to record relative signal intensity, fading, sharpness of tuning, quality, and amount of interference. It was found that the increase of field intensity was approximately proportional to the square root of the power used, and that consequently the area reached with signals of a given intensity was approximately proportional to the power. The fading,

when expressed as percentage fluctuation, was the same for the two amounts of power. Many observers, however, have considered that the fading was less on the high power because there were fewer occasions when the signal diminished below audibility.

A field station for measurements of intensity of received waves was established 5 miles north of the bureau's laboratory, and an auto truck was secured for use as a portable measuring laboratory. This equipment permitted measurements free from the electrical disturbances of various kinds on the bureau grounds. Measurements were made on a number of special transmissions from WGY to test the effects of various antenna arrangements and to determine the transmission possibilities of frequencies in the range from 2,700 to 7,500 kilocycles. In this frequency range, transmission was found to be, in general, irregular, and the portions of the day for best transmission were markedly different for different frequencies.

Cooperative Study of Radio Fading.—The bureau directed a cooperative program of measurements of fading phenomena by a group of university and other laboratories. Six series of special tests were conducted; these consisted of special transmission by station WGY or WJZ for a period of several hours on each of several successive days. Simultaneous measurements were made by means of fading recorders by the cooperating laboratories. In these tests special study was made of signal intensity and fluctuation during the sunset period. The work also included studies of the variations of intensity and fluctuation through the whole 24 hours and the characteristic change from day to night.

This work shed a great deal of light on the nature of radio transmission phenomena. It was found that there is a degree of regularity in the average intensity of fading signals which has not hitherto been suspected. The ratio of average night-to-day intensity was found to have a logarithmic relation to distance; this relation gives quantitative indication that the earth absorption effective in the daytime disappears at night. Results indicated that the characteristic fading observed at considerable distances is due to variable absorption in the upper atmosphere, and that the relatively fast fading observed at distances less than 200 kilometers is largely due to interference between the ground transmitted wave and the wave which has traveled to the Kennelly-Heaviside layer and undergone variable changes of intensity, phase, and polarization. Substantially no correlation between reception conditions and weather phenomena was found. In some of the fading records there was a highly regular periodic type of fading beginning about 15 minutes after sunset. This was produced by interference between waves along the ground and waves refracted from the rising sunset shadow plane in the atmosphere. Calculations based upon it throw considerable light on

the nature and causes of radio wave phenomena near the time of sunset.

Radio Aids to Air Navigation.—A preliminary study was made of the radio aids that would be useful in air navigation. This included a study of the radio equipment that would probably be required on aircraft and at airports. A model of the directive radiobeacon developed by the bureau in 1922 was constructed, and experiments with a view to improving it were begun. The work included an attempt to adapt the beacon to a visual indicator, eliminating the need of the use of headphones by the aviator; the method involved the use of a different modulation frequency on each of the two transmitting coil antennas. Work was begun on the experimental installation of a directive radiobeacon, marker beacon, and radiotelephone transmitting equipment.

National Electrical Safety Code.—Since 1913 the bureau has been engaged in the study of the life hazard in electrical practice and in the preparation and revision of the National Electrical Safety Code. This work has been carried on with the cooperation and assistance of a large number of engineers, many of whom are connected with the electrical operating and manufacturing companies, others being engineers and inspectors of State commissions, municipalities, and insurance underwriters. The various national associations connected with the electrical industry have also cooperated effectively in this work. The latest revision has been made by a sectional committee under the procedure of the American Engineering Standards Committee.

The fourth section of the code consists of five principal parts as follows:

(1) Rules for installation and maintenance of machinery, switchboards, and wiring in generating stations and substations.

(2) Rules for the construction and maintenance of overhead and underground lines for the transmission and distribution of electrical energy and intelligence.

(3) Rules for the installation and maintenance of electrical apparatus and wiring in factories, residences, and wherever electricity is utilized for light, heat, or power.

(4) Rules to be observed by operators in working on or near electrical machinery or lines.

(5) Rules for radio installations.

In addition, there are two sections containing definitions and rules for the protective grounding of circuits and equipment.

The various parts of the new edition, except part 2, have been issued separately. Part 2 is still under discussion, but should be ready for publication early in 1927. After its publication all the parts will be collected into a complete document.

The code has served widely not only as a standard of construction and operation for electrical utility companies, but also as a model for the mandatory rules issued by State officials and commissions, many of whom have adopted it verbatim. It has been the basis of statutes or regulations in California, Illinois, Iowa, Kansas, Michigan, Montana, Nebraska, Nevada, North Carolina, North Dakota, Oklahoma, Oregon, Pennsylvania, Tennessee, Utah, and Wisconsin.

Regulatory authorities concerned with both accident prevention and fire prevention have felt the need of a single code comprising both of these features, and such codes have been worked out locally and adopted in California and Wisconsin. In 1918 the bureau prepared a first edition of such a code combining the provisions of part 3 of the National Electrical Safety Code, and of the National Electrical Code as published by the National Board of Fire Underwriters. This code has been made mandatory in the State of Oregon, and the bureau has prepared successive editions, the last bearing the date 1926.

Industrial Safety Standards.—As a result of the work on the National Electrical Safety Code and the numerous points of contact established with State officials and others interested in such work, the bureau was called upon to enlarge the scope of its work and to consider safety requirements in other than the electrical industry.

In 1919 the bureau held two conferences in Washington at which this subject was considered, and agreement was reached to develop a series of industrial safety codes under the auspices of the American Engineering Standards Committee. Under this arrangement the bureau has undertaken sponsorship for the following safety standards in addition to the electrical codes mentioned above:

Gas safety code (joint sponsorship with the American Gas Association).

Code for the protection of heads and eyes of industrial workers.

Safety code for logging and sawmill operations.

Safety code for aeronautics (joint sponsorship with the Society of Automotive Engineers).

Safety code for elevators, dumbwaiters, and escalators (joint sponsorship with American Society of Mechanical Engineers and the American Institute of Architects).

Code for colors and forms of traffic signals (joint sponsorship with National Safety Council and American Association of State Highway Officials).

Code for protection against lightning (joint sponsorship with the American Institute of Electrical Engineers).

Codes on all of these subjects have been prepared, and all except the last two have been published after approval by the American Engineering Standards Committee. The Head and Eye Code and the Logging Code are issued in handbooks of the bureau, while the others have been published by the joint sponsors.

In general, these codes are intended as guides for safe practice in the industries concerned rather than as a basis for legal regulations.

In some cases, however, their provisions are made mandatory by regulatory bodies. For example, the Industrial Commission of Utah has recently adopted the codes for logging and sawmill operations and for protection of heads and eyes.

Determination of Salinity of Sea Water.—Apparatus was devised at the bureau some time ago for determining salinity of sea water by measurement of its electrical resistivity. This has proved so satisfactory in the international ice patrol service that it has been adopted for regular use, and at the request of the Coast Guard the bureau has built another set of the apparatus so that both vessels used for patrol work can be equipped with it. The determination of salinity and of temperature provides data from which the flow of water can be calculated.

Automobile Lighting.—The motor vehicle act of the State of Oregon designates the National Bureau of Standards as the official testing agency for headlighting devices, and the director of traffic of the District of Columbia has also asked the bureau to make such tests. During the year about 40 devices have been formally tested under the standard specifications which are used in most of the States, and many others have been informally examined. Members of the staff have represented the director of traffic on several occasions at meetings of the Eastern Conference of Motor Vehicle Administrators, and have taken part in the two meetings of the National Conference on Street and Highway Safety, and at the request of the conference committees have given technical advice on the lighting sections of the Uniform Vehicle Code. A report on the use of colored glasses—red, yellow, and green—in tail lamps, stop lights, and direction signal lights was prepared for Secretary Hoover in accordance with a request made by the second national conference.

The bureau has also given assistance on headlighting problems to officers and committees of the American Automobile Association, the Society of Automotive Engineers, the Illuminating Engineering Society, and the Automotive Lighting Association. Circular No. 276, "Motor Vehicle Headlighting," issued in August, 1925, has had a wide circulation, and the folder reprinted from it giving instructions for adjustment of headlamps has been used by thousands in States and cities where headlight campaigns have been carried on.

Soil Corrosion.—About 900 specimens of commercial pipe materials buried approximately four years in 46 kinds of soil, representing soil conditions in nearly all parts of the United States, have been removed for examination. At the same time about 1,400 specimens of galvanized material, pipe-fitting materials, and bituminous protective coatings buried approximately two years ago were also removed. One thousand two hundred additional specimens of pipe

material and protective coatings were buried. The loss of weight and depth of pitting for the metallic specimens and the general condition of the bituminous coatings is being determined and progress reports containing these data will be published in the near future, although final conclusions will not be drawn for several years.

Superconductivity of Metals.—When some metals are brought down to the temperature of liquid helium their electrical resistivity practically disappear, but it is restored if the metal is subjected to a magnetic field exceeding a certain critical value or if electric currents exceeding a critical value are set up in the metal. The bureau's Scientific Paper No. 307, "Note on Electrical Conduction in Metals at Low Temperatures," by F. B. Silsbee, suggested that the fundamental condition was the magnetic field and that currents destroyed the superconducting state only when the current density and distribution was such as to produce the critical magnetic field.

The experimental work on this subject has practically all been done at Leiden; recently H. Kamerlingh Onnes and W. Tuyn have published an account of experiments made there as a crucial test of the Silsbee hypothesis. Different combinations of currents were used in a wire with the concentric cylinder as a return circuit, and results of the experiments were considered to be a qualitative confirmation of the relation suggested. A detailed analysis of the relations between currents, magnetic fields, and the resistance of the circuit at specified temperatures has now been carried through for the particular arrangement of conductors used in the experiments. The agreement between the theoretical results thus obtained and the experimental observations is on the whole very satisfactory. The hypothesis thus seems to be well established and should prove useful in planning further experiments on superconductivity. A scientific paper outlining the theoretical calculations is in preparation.

Fourth Annual Conference of State Public Utility Commission Engineers.—The principle of State control of utility services, such as water supply, gas, electricity, and telephone service, is thoroughly established, and more than 40 States have commissions exercising more or less authority over utility companies. While conditions differ in the several States, there are some general problems which arise in all of them, and general principles which all may follow. In order to promote uniformity of practice and to give a sound technical basis for service rules, the bureau has for years collected information regarding utility service problems and requirements, and has issued several editions of Standards for Gas Service and Standards for Electric Service. Circular 112, Telephone Service, likewise gives the results of a preliminary study looking forward to standards of service in that field. As one of the sponsors for the Code for Electricity Meters, it has during the past year carried out a

revision of this standard jointly with the National Electric Light Association and the Association of Edison Illuminating Companies.

In all of this work the bureau has had the most cordial cooperation of the engineering staffs of the various State commissions, and in order to facilitate the discussion of common problems an annual conference of commission engineers is held at the bureau. The fourth session, May 13 and 14, 1926, was attended by 26 engineers representing 14 States and 2 Canadian Provinces.

At this session reports were presented by committee chairmen on the following subjects:

Selection, use, and care of secondary electric standards for commission purposes. J. F. Meyer, National Bureau of Standards, chairman.

Engineer's place in the field of regulation. I. F. McDonnell, Alabama, chairman.

Service rules for gas, electric, telephone, and water utilities. C. R. Vanneman, New York, chairman.

Electric rates for cooking. C. B. Hayden, Wisconsin, chairman.

Standardization of valuation terms. C. G. Bennett, Illinois, chairman.

There was also discussion of the development of regulation of telephone service, of the revison of the National Electrical Safety Code and the Code for Electricity Meters, and of important special features of the work of the several commissions. No printed report of this conference will be issued, but the committee reports were prepared for circulation in mimeographed form.

Elevator Safety Devices.—In connection with the development of the Safety Code for Elevators, the bureau several years ago made a survey of elevator interlocks and an analysis of elevator accident statistics, which was published as Technologic Paper 202, by C. E. Oakes and J. A. Dickinson. This showed that nearly three-fourths of all elevator accidents to the public occur at the landing doors. Such accidents would be practically all avoided by the use of reliable interlocking devices which prevent the car from leaving a landing unless the hoistway door is closed and locked and likewise prevent the hoistway door from being opened from the landing side unless the car is at rest at that landing. The American standard code, therefore, makes the use of such interlocks mandatory on passenger elevator hoistways.

In the administration of requirments of this kind it has until recently been customary to approve interlock equipment largely on the basis of a visual inspection. When the city of Baltimore, with the cooperation of the National Bureau of Standards, formulated a new elevator code for its own use, it added the requirement that the approval of interlocks should be based on their performance in operation as determined by actual reliability tests to be conducted by the National Bureau of Standards or some other laboratory of similar standing. Five reliability tests were specified—a life-operation test,

a test without lubricant, a test in a moist atmosphere, a test in a dust-laden atmosphere, and a test of the successful operation of the device, under conditions representative of the changes in the alignment of the car and of the hoistway door likely to occur in service.

To carry this provision into practical effect, the National Bureau of Standards thereupon constructed apparatus for automatically operating interlocking devices on a full-scale installation, and from the results of tentative tests of commercial interlocks developed test methods and the detailed test specifications for each of the five reliability tests provided by the code.

The need for reliability tests is shown by the fact that few of the numerous interlocking devices which have been tested successfully met the test specifications without changes in design or construction. Eighteen devices have thus far successfully complied with the test requirements.

The results of these tests are at present used as a basis for approval by the city of Baltimore, the government of the District of Columbia, the Office of the Supervising Architect of the Treasury Department, the State of Iowa, and a group of casualty insurance companies.

WEIGHTS AND MEASURES

Investigation of Carload Freight-Weighing Facilities.—The weighing of commodities in carload lots is a most important accessory to modern commerce. The chief function of the National Bureau of Standards concerning it is the control of weighing standards. Evidently a uniform standard of weight over the entire country is the first essential. The medium of control is a net of 19 master scales used for the calibration of test cars, which are in turn used to test about 12,000 track scales. The bureau undertakes annual calibration of the master scales in terms of the same weight standards. In this manner, the necessary uniform weight standard for all commercial transactions involving charges based on the weights of commodities in carload lots is maintained.

Tests of Track Scales.—The investigation aspect of bureau activity comprises actual test and inspection of several hundred track scales used by carriers for levying freight charges and by industry owners in selling or purchasing commodities in carload lots. Tests of scales are made with special attention to accuracy, and inspection of parts follows each test in an endeavor to discover installation or maintenance faults which may adversely affect the weighing performance. Data and information are obtained through such tests and are used by the bureau in developing restrictive specifications, disseminating beneficial knowledge, and pursuing a consistent program for the improvement of weighing machinery.

Apart from the control and investigation phases of activity, the bureau has for many years sought to improve the adequacy and accu-

racy of freight-weighing facilities by direct contact with individual owners of track scales. Formal reports to the owners of scales tested by the bureau are the chief factors in securing improvement. Results of tests are furnished in detail. Inspection results are made the basis of recommendations for repair, replacement, or maintenance measures as different cases may require.

Three track scale-testing units are operated, and working schedules and itineraries are prepared with a view to distributing the activity and its benefits as equitably as possible throughout all sections of the country. Locations of master scales define primarily the routes to be followed. Seasonal changes are also a guiding factor. In general, only a limited number of scales can be tested in each vicinity, and effort is made to include those of major importance or those for which tests have been formally requested. A number of scales in different classes of weighing service are usually selected to make the resulting data truly representative of conditions in that area. For the reasons just stated it will be apparent that not all requests for test can be complied with, particularly when the location of the scale involved is remote from the route outlined for one of the units.

Tolerances to which the errors of track scales are referred and which the bureau applies to revenue-freight and commercial-freight weighing track scales allow an error equivalent to 0.20 per cent of the weight of the test load employed. The test loads used by the bureau are in no case less than 40,000 pounds.

Master Scales.—Fourteen master scale calibrations were made. All were correct within the very small tolerance prescribed for master scales. Two master scales in the southern district remain to be calibrated.

Test Car Calibrations.—Twenty-seven test cars operated by railroads and industries at points remote from regular master scale facilities were standardized during the year. A commendable trend toward acquisition of approved types of test cars is apparent, and is interpreted as being a response to bureau recommendations for better testing practice and apparatus.

Hæmacytometer Standardization.—An interference comparator for the measurement of the depths of hæmacytometer chambers has been in use during the past year. A new comparator embodying a number of improvements over the original design has been constructed during the past year. The use of these comparators for the measurement of the depths of the hæmacytometer chambers enables the bureau to obtain a higher accuracy with a very great saving of time as compared with older methods. The bureau does no work in the line of counting the corpuscles of the blood with these chambers, but merely standardizes them as to their dimensions.

Accuracy of Dilution Pipettes and Counting Chambers (Hæmacytometers).—Within the past few years many tests of the pipettes and counting chambers used by physicians in making blood counts have been carried out by the bureau. While the accuracy of this type of apparatus is often of the highest importance to the diagnostician, it is an alarming fact that much of the commercial apparatus has been found to be greatly in error. The bureau would point out the grave danger involved in the use of such apparatus unless it is known by actual test to be accurate, or at least to be from a manufacturer in whom confidence can be placed.

Effect of Concentrated Loads on the Length of Measuring Tapes.—An investigation was carried out to determine the effect of concentrated loads on tapes such as are used in precise surveying. This work served to check experimentally several of the corrections used in surveying which are calculated from theoretical considerations. The results are published in S534, by Lewis V. Judson.

Sieve Specifications.—An investigation of sieves was carried out which showed the desirability of certain changes in the specifications of the United States standard sieve series. This investigation is covered in T321, by Lewis V. Judson.

The test of a large number of No. 20, 30, and 40 sieves led to the abandonment by a committee of the A. S. T. M. of old specifications for these sieves and the adoption of the specifications for the United States standard sieve series. The sieves tested were used by a number of laboratories approved by the committee in a comparative test of the old and the new sieves.

A number of different types of grain screens, other than woven wire, were tested for the Department of Agriculture. On the basis of these tests gauges have been made and specifications adopted.

Standardization of Grocers' Paper Bags.—At the request of the Grocery Bag Simplified Practice Committee, this bureau cooperated with manufacturers of grocers' paper bags for the purpose of putting into effect the dimensional standards for this product which had been adopted by the manufacturers. A large group of manufacturers agreed upon the use of an emblem as a guaranty that the bags bearing the emblem were of standard size.

National Conference on Weights and Measures.—The legislative policy of our Government is such as to leave almost entirely to the jurisdiction of the States the regulation of commercial weights and measures. While there are a few Federal laws relating to commercial weights and measures, these are concerned either with the fixing of standards or the regulation of interstate commerce, or sometimes both. The standard barrel law is an example of the first class; the net-weight amendment to the food and drugs act is an example of the second; and the standard lime barrel act and the standard container

act are examples of the third class, these being standards fixed for interstate commerce purposes only.

Since commercial weights and measures are, then, almost wholly regulated by State laws or local ordinances, there is a very urgent necessity for obtaining some uniformity of requirement if efficiency of enforcement is to be obtained and if an intolerable burden is not to be placed upon firms doing an interstate business, especially in the instrumentalities of weighing and measuring. For instance, if all the different jurisdictions were to promulgate nonuniform requirements and subject apparatus to different characters of tests, as might readily be the case if each State arrived at its conclusions independently of the others, the number of varying designs which a manufacturer doing a wide interstate business would be required to produce would be such that no effective standardization would be possible, the stocks necessary to be made and carried would be enormously increased, and the cost of production and the selling price would be very much greater than would otherwise be the case. Moreover no advantage would accrue to anyone and a tremendous economic loss would be the inevitable result. The same conditions would exist if nonuniform-sized packages were to be required for commodities, in general, if various marking requirements were to be insisted upon, etc.

There will shortly be issued by the bureau, the third edition of M20, "Federal and State Laws Relating to Weights and Measures," containing the text of the weights and measures laws now in force throughout the United States. In view of the power of the States to make and enforce their own laws, the only method, under our present policy of legislation, of obtaining uniformity of requirement is by voluntary cooperation among the various jurisdictions. To this end the National Bureau of Standards, shortly after it was established, was instrumental in forming an unofficial organization which came to be known as the National Conference on Weights and Measures. This organization is composed of State and local weights and measures officials from all parts of the United States who meet annually in Washington at the Bureau of Standards for the purpose of discussing problems arising in connection with their work and arriving at uniform solutions which can be put into force and effect in their various jurisdictions. These problems broadly cover weights and measures laws and methods of enforcement, rules and regulations, specifications and tolerances for commercial apparatus, and methods of tests to be applied. The proceedings of the conference are published by the Bureau of Standards, and in this way the material is made available to every one interested in the conclusions.

Model State Law in Relation to Weights and Measures.—As one of the outstanding accomplishments tending toward uniformity along the lines mentioned above, may be cited the model State

law in relation to weights and measures. In cooperation with the National Conference the Bureau of Standards some years ago (in 1911) drafted the so-called model State law on the subject of weights and measures and brought this before the National Conference for action. This was adopted by the Sixth National Conference on Weights and Measures and recommended by the bureau and the conference to the various States for passage. Prior to this time (in 1907), at the third national conference, certain general principles had been agreed upon, but these were not as a rule in such a form that they could be presented as a bill to the various legislatures.

The work of drafting a specific bill was done at a very opportune time for two reasons: First, the Bureau of Standards was then conducting an investigation of commercial weights and measures conditions throughout the country and consequently had first-hand information concerning existing laws and the manner in which these worked out in actual practice; second, as the results of the investigation of conditions became known a number of States had come to a realization of the inadequacy of the laws then on the statute books and were anxious to enact comprehensive laws which would correct the conditions found and furnish a better protection to the merchants and public in their jurisdictions. In the drafting of the law, material from existing laws, from suggestions adopted prior to this time, and from bills based on these suggestions, was freely utilized.

This model law was amplified and improved in 1913 and has been amended from time to time since, when it has developed that improvements could be effected.

It is believed that much of the uniformity in State weights and measures laws which we have to-day is due to the model law. A number of States have adopted it practically unchanged, others have laws which differ from it only in minor respects, and still others have adopted special laws embodying the principles contained in one or more of its sections. About 29 States are embraced in these three classes. Among those States more recently enacting legislation of this character may be mentioned Alabama, Illinois, Indiana, and Virginia, the last-mentioned State having acted in 1926.

The law is presented in three forms which differ mainly in administrative principles to suit the needs of the various jurisdictions. All the forms provide that there shall be a state-wide inspection of commercial weighing and measuring apparatus of all kinds, and checking of package goods and other amounts of commodities determined and ready for delivery; that dry commodities shall be sold by measure of length or weight, or, in proper cases, by count, eliminating the dry measure, and liquid commodities by weight or liquid measure; that all weights and measures shall be net; that special precautions shall be observed in the sale of coal, coke, and charcoal;

that all commodities in package form shall disclose the amount of commodity contained therein; that butter in packages and milk in bottles shall be put up only in standard sizes, and bread baked only in standard weight loaves; and that barrels for fruits, vegetables, and other dry commodities, and baskets for berries and small fruits shall be of standard size. Penalties are provided for violations of the provisions of the law.

Specifications and Tolerances for Commercial Weighing and Measuring Apparatus.—One other outstanding accomplishment of the national conference is the development of specifications and tolerances for commercial apparatus. These cover nearly all classes of apparatus and are designed to procure in commercial use, apparatus which is accurate, which is permanent in its adjustment and will repeat its indications correctly, and which will not facilitate the perpetration of fraud. The codes adopted are believed excellently to serve their intended purpose, they are being more and more generally observed in present-day construction, and it is believed that they have had a very marked effect in improving types of apparatus on the market. The specifications and tolerances have been widely adopted, some 15 or 20 States having officially promulgated them, and it is believed that the considerable uniformity now existing throughout the country is largely attributable to this activity. The codes more recently adopted are concerned with vehicle tanks, fabric-measuring devices, taximeters, portable devices designed for determining the axle loads on loaded trucks on highways (for noncommercial use), and liquid-measuring devices (revision).

Density of Steels.—In the marketing of alloy steels it would be desirable to have tables of the weight per foot of bars or shapes, such as are found in various handbooks for ordinary structural steel. The density of the various alloy steels in various stages of heat treatment is also a matter of some commercial interest. Requests for such data, received from manufacturers, could not be answered with the necessary degree of precision and, therefore, experimental determination of the density of a comprehensive series of alloy steels in various conditions is under way.

Gauge Steel Investigation.—The interchangeability of automobile parts, for example, demands that they be brought to the same dimensions within very close limits. This is accomplished by the use of gauges. If the gauges themselves change dimensions either as a result of the lapse of time or due to wear in use, the desired uniformity in dimensions of the product is not readily attainable.

Work, sponsored by the Gauge Steel Committee, composed of producers and users of gauges, has been in progress at the bureau for several years. The study of the dimensional changes occurring in the hardening, tempering, and aging of the gauges has been com-

pleted save for continued measurements on gauges in progress of aging at room temperatures.

The more important phase at present is the study of the wear of gauges. With the cooperation of several automobile plants service wear records were obtained on a series of gauges, but the results indicated that conditions of use varied so widely as to obscure small metallurgical differences which were being sought.

Due to the large number of variables which enter into gauging operations as carried out in the plant, it was found that obtaining reliable results on "wear" under such conditions would necessitate making up a large number of gauges which would entail considerable expense. In addition, the time consumed in collecting the data from the various cooperating plants tends to make impracticable such procedure for the proper study of the wear problem with respect to gauges. The bureau, accordingly, undertook a laboratory study of this work wherein gauges were subjected to use approximating that obtained in the plant. This was accomplished by the use of a machine especially designed and constructed at the bureau for this purpose. In this manner a control of gauging conditions was assured, comparatively few gauges were required, all tests were centralized at one place, thus permitting of a rapid collection of data and, in general, a more proper study of wear could be obtained than by distributing the work amongst the plants.

Under conditions of test in which potassium-dichromate was used (which will be referred to as "metal-to-metal" wear) chromium plate in the lapped condition showed a wear resistance of about 500 per cent greater than that exhibited by any of the other metals tested. When tested with abrasives chromium plate excelled by 35 per cent in wear resistance. Chromium plate which was not subjected to lapping after plating showed no advantage over the nonfile-hard gauges which in general showed greater resistance to wear than the file-hard gauges in the "metal-to-metal" tests. Stellite showed no advantage in "metal-to-metal" tests over the other materials used and in fact less than the unlapped chromium plate, but gave good results on abrasive wear tests.

Publications.—Dimensional Changes Accompanying the Phenomena of Tempering and Aging Tool Steels. H. Scott, Trans. Am. Soc. Steel Treat., vol. 9, p. 277, 1926.

Wear of Steels with Particular Reference to Plug Gauges. H. J. French and H. K. Herschman, for September, 1926, meeting Am. Soc. Steel Treat.

Density of Denatured Alcohol.—Samples of ethyl alcohol denatured in accordance with various formulas approved by the Prohibition Unit of the Treasury Department were examined by the bureau, and from the results obtained tables were prepared showing the density and weight per gallon. The samples were in part furnished

by the various producers of commercially denatured alcohol, and in part prepared by the bureau. The results, therefore, furnished the information desired for the preparation of tables, and at the same time served as a check upon the accuracy and uniformity of the work of the commercial denaturing plants. The results were published by the Treasury Department.

Density Changes Produced in Glass by Various Heat Treatments.—In cooperation with the optics division an investigation has been carried out to determine the density changes produced in various glasses by various heat treatments. This work is of importance in the design and construction of precision thermometers and lenses.

Short Tests for Sets of Laboratory Weights.—The development of a new system of calibration for sets of weights was completed, and a full description of two forms of this system was published as S527. One of these forms uses the fewest possible number of observations, the other contains a few more observations, thus giving valuable checks on the accuracy of the observations. It is hoped that this relatively simple system will result in more frequent calibration of laboratory weights.

Instructions on Testing Standard Weights.—A paper was prepared for the National Conference on Weights and Measures of the United States, on testing both the ordinary office standards and the standards (commonly called test weights) used in the field testing of commercial scales and weights.

The paper gives information on equipment needed, on precautions to be observed both in preparation for and execution of the work, and describes a very simple short method of substitution weighing by which the testing can be done.

This paper furnishes information much needed in weights and measures departments of States and large cities, in order that a proper standardization of commercial weighing apparatus may be maintained

Dental Research.—Data were secured more rapidly than during any previous year. Contacts have been made with the dental profession through lectures given at Chicago, Washington, New York, and Philadelphia. Committees and members of the American Dental Association have visited the bureau and given unqualified approval of the work. Papers have been published which give fundamental data on wrought gold alloys and appliances used in dentistry. Physical Properties of Dental Materials (III), Progress Report of Research on the Dental Casting Process, by R. L. Coleman, was published in Cosmos, volume 68 (No. 8), page 743, August, 1926. Data are given on many of the important physical properties of materials used in the dental casting process, including waxes, investments, and gold alloys. The effects of variations in manipulative techniques are reported. The methods of testing and the apparatus used are described.

Calibration by Light Waves.—The laboratory is equipped for and is making routine calibrations of strain gauges or similar devices by using the interferometer and counting light waves for desired length intervals. This work can be done quickly and accurately. Duplicate equipment was displayed at the Sesquicentennial Exposition in Philadelphia and is an excellent example of the ease with which the interferometer can be used as a length-measuing instrument.

Thermal Expansion of Tungsten.—The thermal expansion of tungsten (99.98 per cent) over various temperature ranges between $-100°$ and $+500°$ C. was studied. The expansion of tungsten is given by the following empirical equation

$$L_t = L_o\ [1 + (4.28\ t + 0.00058\ t^2)\ 10^{-6}]$$

where L_t represents the length of the metal at any temperature t between $-105°$ and $+502°$ C., and L_o the length at 0° C. Results are published in S515, Thermal Expansion of Tungsten, by Peter Hidnert and W. T. Sweeney.

Measurements on the Thermal Expansion of Fused Silicon.—Results of an investigation on the thermal expansion of transparent and nontransparent fused silica for various temperature ranges between $-125°$ and $+1{,}000°$ C. are given in S524, Measurements on the Thermal Expansion of Fused Silica, by Wilmer Souder and Peter Hidnert; also Silica Rods Expand when Cooled, by Wilmer Souder and Peter Hidnert, Times of India (Bombay), February 4, 1926. A total of 48 expansion tests were made on 17 samples of fused silica.

A detailed description of the apparatus and the methods used in this research and a summary of available data obtained by previous observers on the thermal expansion of fused silica are given.

A critical temperature or minimum length was found at about $-80°$ C. The average coefficient of expansion between 20° and 1,000° C. is 0.48×10^{-6} per° C. This exact value will serve as a comparison standard for other laboratories wishing to calibrate thermal expansivity equipment by the use of fused silica as a standard material.

Time Investigation and Research.—An apparatus has been designed and its practical use demonstrated by which it is possible to obtain time signals from a swinging pendulum without mechanical contact. These signals may be transmitted as desired by use of a relay. The apparatus makes use of the action of a beam of light on a photoelectric cell, when such beam is interrupted by the pendulum swinging through it. A demonstration apparatus designed by this section was exhibited at the Sesquicentennial Exposition at Philadelphia. A brief description of this apparatus was prepared for the Jewelers' Circular, and published June 30, 1926.

HEAT AND POWER

Standard Temperature Scale.—The fundamental temperature scale is based upon the laws of thermodynamics and is established experimentally by means of measurements with the gas thermometer or for higher temperatures, by measurements of the radiation emitted by a black body. For laboratory use it is necessary to have, in addition to the fundamental scale, a standard working scale, for calibration of instruments. In practice, such a scale is defined by a number of thermometric fixed points, such as freezing points or boiling points, and by specifying the interpolation instruments and formulas to be used in defining temperatures between the fixed points. The boiling point of oxygen, −183° C., the freezing and boiling points of water, 0° and 100° C., respectively, the boiling point of sulphur, 444.6° C., and the freezing points of silver, 960.5° C., and gold, 1,063° C., suffice for a standard scale. The platinum resistance thermometer serves as an interpolation instrument for the range −193° to 0° C. and also for the range 0° to 660° C., the platinum *v.* platinum-rhodium (90–10) thermocouple, serves for the range from 660° to 1,063° C., while the disappearing filament pyrometer is used above 1,063°. A scale such as outlined above is in use by the bureau. The adoption of such a standard scale has been the subject of negotiation between the International Bureau of Weights and Measures, the national laboratories of Germany and Great Britain, and the National Bureau of Standards, and, in general, the scale as outlined has been found acceptable as a basis for an international scale, although some details remain to be worked out before formal agreement can be announced. In the meantime, each of the several national laboratories has adopted a standard scale for its own use. These scales conform to the general plan outlined and differ only in minor details, so that international standardization of the temperature scale will probably be a reality in the near future.

Standardization of Rare-Metal Thermocouples.—The proposed international temperature scale in the range 660° to 1,063° C. is based upon four fixed points, namely, the freezing points of zinc, 419.45° C., antimony, 630.5° C., silver, and gold, only the two last named being defined points. The scale which has been used by the Bureau of Standards is based upon three fixed points, the freezing points of zinc, aluminum 660° C., and copper 1,083° C. The platinum *v.* platinum-rhodium (90–10) thermocouple is used for interpolation between fixed points, the electromotive force being represented as a function of the temperature by means of a cubic equation in the former case and by a parabolic equation in the latter.

The small departures of the new scale from the old were determined by calibrating a standard couple at the fixed points of the two scales and comparing the interpolated points obtained.

Pyrometric Cones.—Pyrometric cones are small slender pyramids of triangular cross section made of mixtures of ceramic materials. As made, they constitute a graded series of some 60 members, the compositions of successive members differing in small steps, so that each member will soften and bend over or "come down" at a slightly different temperature from its neighbor in the series. The 60 cones cover the temperature range from 550 to 2,000° C. or 1,000 to 3,600° F.

In the firing of all sorts of ceramic ware, pyrometric cones are placed in various portions of the kiln and the condition of the kiln is judged from the behavior of the cones. It has been the practice in the industry to speak of "cone numbers" very much as one speaks of temperature and it is of great importance to know what relations exist between the two.

This bureau has completed a determination of the temperature at which each one of the complete series of pyrometric cones softens under various conditions in accurately controlled electric furnaces. It was found that the bending of a given cone depends not only on its temperature, but also on the rate at which its temperature has been raised and on the composition of the gases surrounding the cone.

The results of this work have been made available in the form of tables showing the temperatures corresponding to the various cone numbers for two different rates of heating in clean air; with the corrections to be made for the composition of furnace gases.

Standardized Thermometers and Methods of Testing.—Although a large variety of thermometers are submitted for test, there has been a considerable increase in the number of instruments made under standard specifications. The A. S. T. M., through its committee on thermometers, has been active in standardizing the various types of thermometers used in industrial testing and in standardizing the form of the specification itself. This standardized form of specification is coming into general use. A reduction in the variety of thermometers now made and the adoption of a smaller number of standardized forms will be of great benefit to both manufacturers and users. The use of standards identical with the product under test is becoming more general in laboratories which do their own testing. There is also a decided tendency toward adoption of a few standardized forms of partial-immersion thermometers.

Standards for Pressure Measurement.—In the standardization of precision dead-weight pressure gauges constructed some time ago it has been found that measurements of dimensions of the piston and auxiliary measurements involving the viscosity of an oil to determine the width of the crevice can be made with such accuracy as to provide an improved standard for pressue measurement.

Properties of Refrigerating Brines.—The data relating to thermal properties of refrigerating brines, published during 1925, are serving as a basis for standard tables of properties of brines to be issued by the American Society of Refrigerating Engineers.

Thermal Properties of Petroleum Products.—An extensive investigation, partly experimental partly a review of published data, indicates the possiblity of correlating the more important thermal properties, such as specific heat, latent heat, etc., with density of petroleum products in a simple manner. The standard oil tables, issued by the bureau as C154, contain in a publication of 175 pages data on virtually a single property—thermal expansion—as related to density. Standard data on the other thermal properties are under investigation.

Thermal Conductivity of Insulating Materials.—During the year measurements of thermal conductivity and density were made on a large number of thermal insulating materials, primarily those used for cold storage and house insulation. The method of measurement developed at the bureau consists essentially in observing the rate of heat flow and temperature drop through a flat, square specimen of material of measured thickness confined between two metal plates between which a constant difference in temperature is maintained by electrically heating one of the plates and water cooling the other. Actually the arrangement is more complicated, since means must be provided to eliminate undesirable heat loss at the edges of the hot plate and specimen. This method of measurement yields the thermal or heat conductivity, a specific property of a material, upon which its insulating value depends. Effects due to the resistance to heat flow between the surface of a material and the surrounding air or other medium are eliminated, since these insulating effects are not ordinarily utilized in building construction, and in any case they depend upon the manner in which the material is used.

Differences in the respective insulating values of equal thicknesses of the various fibrous or cellular materials weighing less than about 15 pounds per cubic foot are rather small, the advantage from the point of view of insulating value only being with the lighter and least-compressed materials. The thermal conductivities of all such materials are within the range 0.26 to 0.36 B. t. u. per hour per square foot and temperature gradient of 1° F. per inch thickness. The compression and binding of fibers to obtain structural strength entails some sacrifice of insulating value. Heavy wall boards, consisting chiefly of plaster of one kind or another, are poor insulators, although they have certain advantages, such as fire resistance and resistance to air infiltration into the building.

Thermal Conductivity at High Temperatures.—Work on thermal conductivity of insulating materials at high temperatures up to

800° C. is in its preliminary stages, the work thus far having consisted in the calibration and standardization of an apparatus built in previous years for measuring insulating values.

Heat Transfer Through Building Walls.—Measurements of insulating value of typical building walls have been continued to provide standard engineering data for use in building construction and equipment. The method consists in maintaining a constant difference in temperature between the opposite sides of a system composed of a 3 by 6 foot wall section and a relatively thin panel of composition cork placed in contact with the warm surface of the wall panel. When a steady state of heat flow is established, the rate of heat flow is the same through both panels and the ratio of the temperature drops through the two is a measure of their relative insulating values. The insulating value of the thin cork layer is readily measured by other means, and the actual insulating value of the wall panel is thus calculated.

The work this year, aside from construction of accessory equipment, has included various tests on frame construction to determine the effect of the air spaces and to eliminate certain errors inherent in testing relatively small panels of hollow construction.

Development and Improvement of Low-Temperature Apparatus and Technique.—Several very serious accidents in laboratories have resulted from the use of flammable liquids, such as volatile petroleum distillates, or toluene, to form the bath of a cryostat. In some instances, explosions have occurred and burning liquid has been thrown upon the operator.

"Nonflammable Liquids for Cryostats," S520, by Dr. C. W. Kanolt, sets forth the results of his experiments undertaken to find nonflammable liquids suitable for use in low temperature (about −150° C.) cryostats and to study some of their properties.

The materials tried were chlorine and bromine derivatives of methane, ethane, and ethylene, and mixtures of these liquids. The eutectic compositions and freezing temperatures of mixtures of two, three, and four components were determined, and some mixtures of five components were investigated.

Some of the mixtures become very viscous at temperatures near their freezing points, and the limits of usefulness of these mixtures were determined by their viscosities rather than their freezing points. The corrosiveness of the liquids to metals was also studied.

A new type of vacuum flask has been developed for storing liquid hydrogen. In this flask, the heat leakage from the outside to the liquid hydrogen was reduced to a minimum by increasing the resistance to heat conduction and by reducing the absorbing power of the flask for external radiation. The flask was made of pyrex glass for strength. The resistance to heat conduction was increased by

making the neck of the flask long and narrow. The absorbing power for external radiation was decreased by surrounding the inner glass cylinder with several sheaths of bright copper foil separated from each other. These copper sheaths are more effective than a silver film in shielding the flask from external radiation. Liquid hydrogen can be kept longer in this type of flask than in other types now in use.

A new cryostat is being designed for greater safety and for the maintenance of a constant temperature.

Properties of Matter at Low Temperatures.—Experimental determinations of the thermal conductivity of lithium, sodium, and lead at low temperatures were carried out in the low temperature laboratory of the Bureau of Standards.

The method was essentially the bar method of Forbes. The metal rod, centered in a large test tube, was placed in a constant temperature bath and heated by a coil at its upper end. The temperature gradient was determined by thermojunctions spaced along the rod. With the mean temperature not exceeding 15° above the bath temperature, accurate values of the conductivities were obtained. Values for lead from −250° to +100° C., taken to test the method, agreed well with the best recorded values. Lithium shows a linear increase in conductivity from 0.15 at 0° C. to 0.20 at −200° C., thereafter rising sharply to 1.00 at −246° C. Above 0° C., a minimum occurs at +40° C. and an increase thereafter to 0.17 at +140° C. Sodium shows a linear increase from 0.28 at −40° C. to 0.40 at −240° C. Above −40° C. an increase occurs to 0.35 at 0° C. and thereafter a decrease to 0.28 at +65° C.

Fire Resistive Properties of Building Materials.—Fire Tests of Brick Walls.—The fire tests with brick walls were undertaken to obtain information on which safe and economical use of the material can be based. Municipal building law requirements vary greatly relative to prescribed wall thicknesses which has been due in part to lack of definite knowledge on the stability and heat insulation afforded under fire conditions. The fire tests conducted this year were mainly on heavy walls to obtain the ultimate endurance in ability to support load and protect combustible material on the unexposed side while exposed to the test fire on the opposite side. This has been found to vary with the wall thickness and the kind of brick from approximately 1 hour for 4-inch walls to 10 hours or more for 12-inch walls.

Through articles published in outside journals giving progress reports and contact with States, cities, and other bodies formulating or revising building codes, much of the information obtained has found immediate application, and it is expected that the full report of the investigation which is nearing completion will assist essentially

in obtaining uniform standards for design and regulation consistent with the properties developed in the tests.

Hollow Tile Investigation.—The use of clay hollow tile for load-bearing purposes in walls is of comparatively recent origin, and building design and public regulation standards show even greater variance in provisions than for brick. According to some city codes its use for load-bearing purposes is practically prohibited, while in other cities it is used within certain limitations on a parity with brick. Prior to the tests at the National Bureau of Standards there was extant little data from tests other than of individual units. About 200 fire tests of walls have now been completed, the tests during the present year covering special forms of units and designs of walls, tests of material from sources not previously covered, 12-inch and 16-inch plastered and unplastered walls tested to ultimate endurance, as also tests to determine the effect of certain manufacturing details on fire resistance, such as methods of preparation of the raw clay and addition to it of various percentages of combustible fillers.

On account of tests involving manufacturing details and the wide scope of the work generally it was found necessary to conduct it in cooperation with the industry as represented by the Hollow Building Tile Association. A progress report was presented before the annual meeting of this association,[4] and a paper giving results of the tests from the standpoint of public regulation of building construction was given before the Building Officials' Conference.[5] LC113 on "Fire Resistance of Hollow Tile" was revised to include results from recent tests. The results of compression, absorption, and freezing tests of individual units have been utilized in formulating specifications, standard specifications based largely on these tests being adopted during the year by the American Society for Testing Materials.

Intensity and Duration of Building Fires.—On account of the variety in design and materials used in fire resistive construction and for the protection of structural members, it is difficult to specify construction details and protection thicknesses in building codes and the practice is becoming more general of specifying fire-endurance periods for given constructions, buildings or occupancies, as referred to performance in standard fire tests. It is therefore necessary to know within limits the probable intensity and duration of the fires such buildings and occupancies can occasion. Examination of fire ruins has given indications of fire intensity through fused metals and general structural effects, but neither the ruins or records of the fire give any reliable information on the effective duration as referred

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[4] Proceedings Eighth Annual Meeting, pp. 90–114; 1926.

[5] "The fire resistance of clay hollow load-bearing wall tile" by H. D. Foster, Proceedings, Twelfth Annual Meeting, pp. 103–110; 1926.

to a given part of the building. Tests to obtain such information for the case of office buildings have been conducted at the Bureau of Standards during past years, a one-story fire resistive building, 15 by 30 feet in inside lateral dimensions having been burnt out three times with old office furniture and with or without a wood top floor, with measurements of temperatures at representative points within the room and in the débris. In two tests the fire was given a quick start by burning a large amount of readily combustible materials in one corner until the temperature over most of the room was at or above the ignition points of wood and paper, this being representative of conditions where a fire breaks into a room or building from an adjoining room or building. In the other test the fire was given a slow start from fire in a waste-paper basket. A fourth test was conducted with a record storage or reference room occupancy which is considered as creating the severest fires in office buildings. During the present year the latter test was repeated in a larger structure 30 by 60 feet in inside lateral dimensions in order to obtain any effects that might be caused by the larger room size. For the same reason a burning-out test of regular office occupancy with wood furniture and wood top floor was also repeated in the larger structure. Higher temperatures and longer duration obtained than in the previous tests with office occupancy, the maximum temperatures indicated for different points in the room ranging from 871 to 1,142° C. (1,600 to 2,088° F.). The smaller structure was then burnt out, fitted with steel furniture consisting of filing cabinets, desks, and open and closed shelving, with contained and exposed records somewhat exceeding in volume what was present in the tests with wood furniture. Two tests with slow start for the fire and one with exposure start were made with Portland cement top floor finish and one each with slow and exposure start and pine top flooring. When the temperature data from these later tests have been reduced and considered in connection with that obtained for the earlier tests, information sufficient to define the range of exposures incident with the given occupancy will be available.

Sheet Steel Garages.—Two burning-out tests were conducted with steel-framed sheet steel garages to determine the hazard to adjacent construction. The garages were erected by the Sheet Steel Trade Extension Committee and two old automobiles with other incidental contents were provided for each test. Wood-finished and sheet-steel walls were placed 1 to 5 feet away from the garage burnt out. A brief description of the tests with summary of results has been published in the Quarterly of the National Fire Protection Association, vol. 20, No. 1, pp. 60–63; July, 1926. It is expected that the results will aid materially in securing greater uniformity in

city regulations relative to the required distance from the lot line or adjacent construction for such buildings.

Supercharging of Aircraft Engines.—This activity has as its purpose the determination of the improvement in engine performance under altitude conditions made possible by supercharging.

The first problem, undertaken last year for the National Advisory Committee for Aeronautics, was an investigation of the performance which a Liberty 12 and a Curtiss D–12 engine would give if equipped with an ideal supercharger; that is, with a supercharger which consumed no power in its operation. This was accomplished by testing each engine in the altitude chamber under conditions of temperature and pressure corresponding to altitudes up to 25,000 feet, but at all times maintaining sea-level pressure at the entrance to the carburetor. These tests were completed in May, 1926, and a report is being prepared for publication by the National Advisory Committee for Aeronautics. In the case of the Liberty engine in particular, the increase in power due to supercharging at high altitudes was slightly less than that calculated from the corresponding intake and exhaust pressures.

The second problem, undertaken in 1926 for the Army Air Corps, is the test of the Curtiss D–12 engine, under temperature and pressure conditions corresponding to various altitudes, when equipped with mechanically driven superchargers. The tests should be completed by the end of the year, but no results are yet available. Before starting this work, tests were made in the altitude laboratory of the Curtiss D–12 engine equipped with an automatically controlled carburator designed to supply a constant fuel-air mixture at various altitudes. Good performance was obtained and a report has been made to the engineering division of the Air Corps.

Lubrication of Aircraft Engines in Starting.—Numerous engine failures have been attributed to insufficient lubrication during the starting period when oil temperatures and engine temperatures are extremely low. At the request of the Bureau of Aeronautics, Navy Department, lubrication under low temperature conditions has been studied. For this purpose a 200-horsepower aircraft engine has been mounted in the cold room and measurements of oil flow made for various oils and conditions of operation. Many commercial oils meeting the present Navy specification for winter oil have been tested, and it appears that, in general, the viscosity under operating conditions rather than the pour point governs flow, provided an adequate supply of oil is available at the suction side of the pump. It should be noted, however, that two oils having the same viscosity at 210° F. may differ materially in viscosity at an operating temperature of 32° F.

In the conventional type of lubrication system the pressure producing flow to the intake side of the pump can not exceed atmospheric pressure. As atmospheric pressure decreases with altitude, the maximum pressure available for producing flow to the suction side of the pump must also decrease. It is particularly important in the case of aircraft engines, therefore, that the suction line to the oil pump be not unduly restricted. In some engines, at least, considerable improvement would result from increasing the area of the passages within the engine itself. The possibility of inadequate flow at low temperatures was emphasized by one experiment in which the oil discharge from a conventional pump was 7 pounds per hour at a temperature of 10° F., whereas its capacity at normal operating temperatures was 2,750 pounds per hour.

The operating temperatures of aviation engines do not vary appreciably with the seasons, the only reason for the present use of a special winter oil being the difficulty of lubricating the engines at low temperatures while starting. It is believed that a suitable oil for both winter and summer use may be developed as a result of this investigation. The value of such a development in its relation to problems of supply and distribution is obvious.

Friction of Aviation Engines.—A report of this investigation has been completed and submitted to the National Advisory Committee for Aeronautics. The first part of this report deals with the influence of changes in operating conditions upon the friction of aviation engines as shown by friction measurements in the altitude laboratory. The second part presents and discusses the results obtained with a group of pistons so constructed as to differ from each other in a single respect, such as length, clearance, area of thrust face, location of thrust face, etc.

Phenomena of Combustion.—This project has been supported for several years by the National Advisory Committee for Aeronautics. It is primarily an investigation of the kinetics of explosive gaseous reactions and is furnishing fundamental data as to the influence of temperature, pressure, and composition on the velocity of such reactions. A soap bubble, filled with the explosive mixture and fired at its center, serves as a constant pressure bomb and the progress of the explosive reaction is recorded automatically by photographic means. For pressures other than atmospheric the bubble is still used as a constant pressure bomb by inclosing it in a sufficiently large container within which the pressure may be brought to the desired value. Last year the study of the carbon monoxide-oxygen reaction was extended to pressures as high as 4 atmospheres. In the current year the same reaction has been studied at pressures less than atmospheric. The methane-oxygen reaction has been studied in the range from 3½ atmospheres down to less than one-half atmos-

phere. Work has also been done on the reaction with oxygen of carbon monoxide-methane, carbon monoxide-hydrogen, and more complex mixtures. All the results obtained thus far are consistent with the theoretical assumption that the linear rate of flame advance relative to the unburned gas is proportional to the product of the concentractions (partial pressures) of the active components. The bubble method also gives accurate thermodynamic data on the reactions. Preliminary measurements have been made of the rate of flame spread of mixtures of alcohol vapor and oxygen using a burner and photographing the cone of flame as was done in some of the early experimental work on this project.

Publications.—The Rate of Flame Propagation in Gaseous Explosive Reactions, F. W. Stevens, Journal of the American Chemical Society, vol. 48, p. 1896; 1926. Fortpflanzungsgeschiwindigkeit der Flamme beder Explosion von Gasen, F. W. Stevens, Zeitschrift des Vereines deutscher Ingenieure, Nr. 20/1926 S. 659. Note on the Thermodynamics and Kinetics of Gaseous Explosive Reactions, F. W. Stevens, National Academy of Sciences.

Detonation Survey.—As a step toward greater uniformity in measuring and rating the antiknock value of fuels, a survey has been undertaken of the methods now in use, and comparative engine tests have been run on a number of representative samples of commercial gasoline submitted for the purpose of enabling the American Petroleum Institute to make a preliminary estimate as to the detonation characteristics of the types of gasoline now commercially available.

Economic Volatility of Motor Fuels.—For a number of years this project has been conducted in cooperation with the American Petroleum Institute, the National Automobile Chamber of Commerce and the Society of Automotive Engineers. Informal reports of progress are made to a steering committee and formal reports are presented at the annual meetings of the American Petroleum Institute and at the semiannual meetings of the Society of Automotive Engineers. The following papers have been published during the year, based on this project:

Progress Report of Engine Starting Tests. J. O. Eisinger, Journal of the Society of Automotive Engineers, vol. 18, p. 127; 1926.

Effects of Fuel and Engine Design on Starting. S. W. Sparrow, Bulletin American Petroleum Institute (April 12, 1926), p. 121.

Progress in the Measurement of Fuel Volatility. T. S. Sligh, jr., Journal of the Society of Automotive Engineers, vol. 18, p. 393; 1926.

Volatility Tests for Automobile Fuels. T. S. Sligh, jr., Journal of the Society of Automotive Engineers, vol. 19; 1926.

Engine Starting.—A marked increase in the use of closed cars and a nation-wide program of road development have increased greatly the winter operation of automobiles. Starting cars in cold weather is one of the outstanding difficulties of winter operation.

This problem has been studied both from the standpoint of improvements in fuel and improvements in engine design which would help the situation. Tests made on a commercial fuel, which conforms with Government specification for motor gasoline, gave the following results:

Mixture supplied air-fuel by weight	Starts per gallon at—	
	30° F.	68° F.
1 to 1	116	165
2 to 1	104	227
3 to 1	86	221

The engine employed in the tests was a 4-cylinder truck engine with a piston displacement of 425 cubic inches.

Methods for Testing Petroleum Products.—Work on methods for testing petroleum products has been done in cooperation with various subcommittees of Committee D–2 on Petroleum Products and Lubricants of the American Society for Testing Materials.

In general, the work has consisted in testing the product for comparison with results obtained by other laboratories to secure information regarding reproducibility and other features essential to a satisfactory method of test. Such cooperative work is preliminary to, and often results in, the adoption of standard methods for testing petroleum products.

Considerable work has been done with reference to the measurement of consistency (viscosity or plasticity). The bureau is now prepared to furnish standard viscosity samples, thus enabling oil refiners, commercial oil-testing laboratories, etc., to maintain a uniform standard of viscosity. A diagram has been devised by means of which the Saybolt viscosity of a petroleum oil at any temperature within a wide range may be found from the known viscosity at one temperature. Two new types of instruments, (1) the viscomparator and (2) the burette consistometer, have been developed.

The viscomparator makes use of the comparison method of determining viscosity, thus avoiding many of the errors of the more usual types of commercial viscometers. While the viscomparator has not yet been investigated extensively, it gives promise of being very convenient, rapid, and accurate and should prove a valuable addition to standard methods of determining viscosity.

By means of the burette consistometer, flow-pressure diagrams of either viscous or plastic substances can be determined rapidly and accurately. The instrument is suitable for use with a somewhat restricted range of materials, inasmuch as the available pressure is that provided by the hydrostatic head in the burette. Because of its speed and accuracy it should, however, be a welcome addition to

36316—27——14

standard methods of test for those materials to which it is applicable. Description of the calibration of two instruments of this type may be found in an article entitled "Calibration of the Burette Consistometer," by Winslow H. Herschel and Ronald Bulkley, to be published in Industrial Engineering Chemistry early in 1927.

The following articles concerning plastic materials have been published:

"The measurement of consistency as applied to rubber-benzine solutions," Winslow H. Herschel and Ronald Bulkley, Kolloid Zeitschrift, vol. 39, p. 291; 1926.

"Consistency," by Winslow H. Herschel, being a chapter in a textbook on Colloid Chemistry, Theoretical and Applied, by Jerome Alexander. See vol. 1 p. 727, published, 1926, by McGraw-Hill Book Co.

Automobile Braking Systems.—The Safety Code for Brakes and Brake Testing has been completed and is now in the hands of the sectional committee of the American Engineering Standards Committee for presentation to that body for approval as a tentative American standard. In the past two years the bureau has secured a considerable amount of technical information which served as a basis for this code. Figure 36 presents a statistical analysis of data collected by the bureau as to the performance of hand and foot brakes on passenger cars and motor trucks in actual service. The final draft of the code was completed after a thorough canvas of all interested parties. Every effort was made by the sponsors—the Bureau of Standards and the American Automobile Association—to insure adequate consideration of all controversial points, of which there were a number involved. The code proposes eventually to require for all motor vehicles that the foot brake shall be capable of stopping the vehicle within a distance of 50 feet from 20 miles an hour and that the hand brake shall be capable of stopping the vehicle within 75 feet from the same speed. This can be met to-day by the average passenger vehicle, but greater stopping distances are to be permitted for a limited time in the case of certain classes of vehicles which at present have much poorer braking ability.

The type of decelerometer developed at the bureau is being produced commercially, and the bureau's advice is frequently sought by manufacturers interested in developing other types. It is estimated that nearly a thousand decelerometers of various makes are now in service. They are employed for brake testing by police officers, service stations, automobile clubs, etc., in some 30 eastern cities. Massachusetts and the District of Columbia have been pioneers in the adoption of scientific methods of brake testing. A number of commercial decelerometers have been tested at the bureau during the present year, among them one foreign type not previously on the market in this country. In every instance there was good

agreement between the readings of the instrument and computed values.

An analysis has been made of the causes of automobile skidding, the forces involved therein, and the dimensional quantities of the automobile which affect its road stability. This analysis has been supplemented by experiments on a model car, the weight distribution of which, as well as the moment of inertia about its center of gravity, is known.

Automobile Brake Linings.—The experience and information gained in the testing of materials used for brake linings of automotive vehicles has made possible further improvements in the testing equipment and methods. The increased desire of brake-lining manufacturers and car builders to obtain for their own use such test equipment has made it desirable to complete the working out of all details, so that arrangements could be made for making such equipment available in fully satisfactory form and at a reasonable cost. One set of improved equipment was put into operation at the beginning of the year, and after a thorough try out of this it has been possible to complete and place in service two additional units. The development of automatic pressure adjustment has also been completed, thus enabling the operator to handle a number of equipment units, requiring his attention during operation only for the periodic taking of readings.

The routine tests of new materials have been continued and the data obtained furnished to Government service departments as a basis for making purchases and to manufacturers for their information.

The results of this project have enabled manufacturers to increase the quality of operation and durability of the average brake lining by approximately 100 per cent.

The added equipment has made it possible to carry on experimentation for determining suitable conditions for supplementary tests. This applies, in particular, to the development of the long-planned "light-service" durability test to supplement the fully developed "severe-service" test regularly used. Considerable preliminary work in this direction has been done, and it is expected that suitable conditions for a satisfactory "light service" test can shortly be determined.

Performance of Brake Linings in Service.—A paper by H. H. Allen, describing the performance of brake linings on an actual car with respect to the influence upon the coefficient of friction of the temperature of the brake linings, the presence of water, and the presence of oil, will be published in the Journal of the Society of Automotive Engineers. The experiments indicated that the influence of temperature upon the coefficient of friction is due almost entirely to its influence upon the impregnating material used in the lining.

Brake linings when soaked with oil show rather constant coefficients of friction, the value being about half that for a normal lining. The coefficient of friction for a water-soaked lining is usually less than that for a dry lining, but the value is likely to increase materially in service within a short period of time.

Antifreezing Solutions for Automobile Radiators.—Last year saw an unusual number of trade-marked preparations for radiator use offered to the public in competition with denatured alcohol, and the bureau's letter circular on this subject was revised in December, 1925, to include the results of additional experimental work on the relative merits of denatured alcohol, glycerin, and the glycols. During the present year a variety of commercial radiator preparations have been received for examination and comment, but denatured alcohol, distilled glycerin, and ethylene glycol appear to be more satisfactory than any of the others which have been proposed. The study of commercial grades of glycerin and glycol is being continued in cooperation with the Federal Specifications Board, which has undertaken to prepare standard purchase specifications for antifreezing solutions. A paper on "Antifreeze solutions and compounds," by H. K. Cummings, appeared in the Journal of the Society of Automotive Engineers (Vol. 19, p. 93).

Motor-Vehicle Rating for Taxation.—About two years ago, at the request of one of the States, an investigation was started with the purpose of devising a simple and equitable system for determining motor-truck registration fees. The scope of the investigation was later enlarged to include the special taxation of all motor vehicles. A formula for computing registration fees, applicable to all types of motor vehicles and capable of being adjusted to accompany different rates of fuel tax, was recommended. Constants were calculated to yield the desired revenue, and a final report of the work was submitted to the State in August, 1926.

OPTICS

Standard Wave Lengths.—Wave-length standards of light represented by monochromatic spectral lines are fundamental data for measurements in spectroscopy, astrophysics, metrology, and precision optics. The first system of standard wave lengths of importance was the "Preliminary Table of Solar Spectrum Wave Lengths" published by Professor Rowland in 1888. Five years later the absolute measurements of Michelson and Benoit on cadmium lines in terms of the standard meter at Paris showed that Rowland's wave lengths were too large by 1/30,000 and some redeterminations of solar spectrum standards by Fabry and Perot in 1901 revealed relative errors of 1/100,000 in Rowland's table. During the past 20 years a con-

certed effort has been made to improve the standards for wave-length measurements. In 1907 the International Union for Cooperation in Solar Research adopted the following resolution:

> The wave length of the red ray of light from cadmium produced by a tube with electrodes is 6,438.4696 Ångstroms in dry air at 15° on the hydrogen thermometer, at a pressure of 760 mm. of mercury, the value of g being 980.67 cm per sec.^{2} (45°). This number will be the definition of the unit of wave length.

From time to time the wave lengths of lines in the spectrum of the iron arc have been compared with this primary standard and the mean of three values for each line, by independent observers using interferometer methods for making the comparison, was officially adopted as a secondary standard of wave length. In this way, by 1914, a set of nearly 100 standards was built up, each one of which was believed to be correct to a thousandth of an Ångstrom unit. Later investigations on the so-called "pole effect" and on the iron arc in vacuum showed that some of the lines were sensitive to operating conditions and more detailed specifications of the manner in which a standard wave length is produced were required.

Official action has been taken by the International Astronomical Union, which has replaced the International Union for Cooperation in Solar Research, and increased precision of standard wave lengths is aimed at. The Bureau of Standards has remeasured the iron standards produced according to the revised specification of the iron arc and found that the adopted values in the red are about 1 part in 1,000,000 too large. Our experience with precise comparisons of wave lengths causes us to favor the use of luminous sources operated at low pressure. Spectrum tubes containing gases at a few millimeters of mercury pressure furnish the sharpest and most easily reproducible lines; and it is probable that a more satisfactory system of standard wave lengths could be obtained from iron vapor if the arc were operated at reduced pressure so that disturbing influences like pressure shift, pole effect, and Stark effect are eliminated. During the past year a newly constructed vacuum arc has been used for the redetermination of wave-length standards in the spectra of iron, titanium, and other metals. The vacuum values of these lines are furthermore required for comparison with the solar values of the same lines, since it is now believed that the pressure in the reversing layer of the sun is only a very small fraction of an atmosphere. For the purpose of correcting Rowland's table, and in order that the new laboratory data from vacuum arcs may be compared with solar values, this laboratory has cooperated for several years with the Allegheny Observatory on a program of standard solar wave lengths. During the past year the first installment of our results dealing with wave lengths in the blue portion of the spectrum was published, and observations on the violet and on the yellow and red regions were

completed. Twelve papers on the subject of standard wave lengths have been published by members of the bureau staff.

Spectral Structures.—Empirical methods of identifying chemical elements by means of their spectra have shown that among all the lines of any particular spectrum only a few possess superior spectrochemical sensitivity. These are the last lines to disappear as the element is progressively diluted until only a mere trace remains. It was suspected that these sensitive lines must be governed by some general law of spectra and that their explanation would be found in the structure of the radiating atoms. This has, indeed, been found to be the case, since the structures of complex spectra have been successfully analyzed with the aid of interpretations from the quantum theory of spectroscopy. According to this theory each spectrum line is produced by a change in atomic energy, the change for emission of radiation taking place from a higher to a lower energy level, each state and the transition being defined by certain quantum numbers. For the production of the most sensitive lines for spectrochemical detection it is the rule that large quantum numbers and low energy states are involved, and it is important to analyze all the spectra for the purpose of identifying the energy levels responsible for these ultimate lines. The spectroscopy section of this bureau has for several years carried on a program of investigations on structures of complex spectra, and rapid progress has been made in the classification of spectral lines. During the past year a summary of the work on spectral structures for "Elements of the Second Long Period (Rb to Pd)" was published and the arc and spark spectra of zirconium and lanthanum were analyzed in detail. For the identification of energy states or spectral terms, special descriptions of the spectra, such as absorption spectra and Zeeman effects, are of great importance. Accordingly, the absorption spectra of metals produced in under water sparks have been investigated and used in the extension of the classification, in particular of Fe, Co, Ni, Ru, Rh, Pd, Os, Ir, and Pt lines. Zeeman effects were obtained in cooperation with the University of Nebraska, and results have been compiled for the spectra of yttrium, zirconium, lanthanum, and tantalum. The structure of the ionized lanthanum spectrum is represented by Figure 37. Thirteen papers on the structures of spectra have been published by members of the bureau staff during the past two years; those of the present year are—

"Arc spectrum regularities for ruthenium," W. F. Meggers and O. Laporte, J. Wash. Acad. Sci., **16**, p. 143; 1926.

"Spectral structures for elements of the second long period," W. F. Meggers and C. C. Kiess, J. O. S. A. and R. S. I., **12**, p. 417; 1926.

"Multiplets in spectrum des ioniziertan vanadiums," W. F. Meggers. Zeits. f. Physik. **33**, p. 509; 1925. Ebenda, **39**, p. 114; 1926.

"Absorption spectra of the palladium and platinum triads," W. F. Meggers and O. Laporte, Phys. Rev., **28**, p. 642; 1926.

"Ueber die grundterme der spectren der ersten und zweiten grossen periode," O. Laporte, Zeits. F. Physik., **39**, 123; 1926.

"Structure of LaI Spectrum," W. F. Meggers, Wash. Acad.; 1926.

Standards of Radiation.—During recent years there has been a marked increase in the use of ultra-violet and visible radiation as stimuli (1) by chemists for producing photochemical reactions, (2) by biologists and physiologists in their investigations of the radiant energy upon lower organisms, (3) by psychologists in their studies of the effect of light upon the eye, (4) by physicists in their investigations of photoelectric phenomena, and (5) very recently by the medical profession interested in phototherapy.

In all such investigations it is important to know the energy value (the mechanical equivalent) of the different radiations (wave lengths) used as stimuli. For this purpose it is most convenient to measure the unknown radiation stimulus by means of a nonselective radiometer calibrated by exposure to a standard of radiation.

The Bureau of Standards has the unique distinction of establishing and issuing such standards, consisting of seasoned carbon-filament incandescent lamps similar to the well-known light standards.

The original lamp standards of radiation were established early in 1914. In these radiant flux per cm^2 at 1 meter from the lamp was established in absolute value (1) indirectly by comparison of the lamp with a black body in which the coefficient of radiation was taken as -5.7×10^{-12} watts per cm^2, (2) by direct measurement using radiometric instruments especially devised for the purpose.

These two methods gave values which were in agreement within 0.5 per cent. Hence the standard of radiation as defined by these incandescent lamps may be considered well established.

Up to the present more than 50 of these standards have been issued to the public, the demand increasing in magnitude as their utility becomes better known.

New lamps have been added from time to time to the bureau's original standards, and since the lamps may be intercompared with an accuracy of 1 to 2 parts in 1,000, and original standards are used but little, there is no difficulty in maintaining the standard. The following table shows the values characteristic of these standards:

Amperes	Volts	Radiation intensity per mm^2 at distance of 2.0 meters
0.250	79.9	42.6×10^{-8} watt.
.300	94.8	62.7×10^{-8} watt.
.350	109.8	86.7×10^{-8} watt.
.400	125.0	114.4×10^{-8} watt.

Radiometric Measurements on Various Carbon Arcs and Other Sources Used in Phototherapy.—The therapeutic value of sunshine is recognized, especially of its ultra-violet component. But sunshine is limited both as to time and place, hence the search for a source of radiation having the same spectral energy distribution in the ultra-violet as the sun.

Cooperative with the research laboratory of the National Carbon Co., the problem has recently been attacked by two methods—(1) The spectral energy distribution, in the visible and ultra-violet, of the central line through the arc and the incandescent electrodes was obtained by means of a quartz spectroradiometer; (2) by means of properly chosen transmission screens, the spectral radiation components of the whole arc (including reflectors if present) were obtained in seven steps throughout the entire spectrum.

Publication.—" Radiometric measurements on the carbon arc and other sources used in phototherapy," by W. W. Coblentz, M. J. Dorcas, and C. W. Hughes, J. Am. Med. Assn. (In press.)

The effect on the ultra-violet component of (*a*) the kind and size of carbons, (*b*) carbon electrodes having soft carbon or various metal cores, and (*c*) alternating or direct current, was investigated.

From a comparison of the data obtained with those on the sun, the gas-filled tungsten lamp, the quartz mercury arc, and the arc between rods of tungsten and of nickel it is concluded that while the carbon arc approaches nearest the sun in spectral energy distribution (see fig. 38) it is important to use the proper size of electrodes and magnitude of current to obtain the most efficient operation of the lamp. Furthermore, the same relative proportions of ultra-violet to total radiation can be obtained from units operating on 20 to 30 amperes as with those taking 90 to 125 amperes. The latter type is useful for large installations, while the cheaper type is of special importance to individuals who wish to have their own.

Standardization of Eye Protective Glasses.—The National Safety Code for the Protection of the Heads and Eyes of Industrial Workers prescribes rules and methods for testing the opacity of goggles material for the various spectral regions of radiation. The ultra-violet is the most harmful and its presence contributes nothing toward visual inspection. It has been adequately eliminated from certain types of glasses for some time past. The infra-red, also, makes no contribution of value in visual inspection, but its elimination has not been so rigidly sought as that of the ultra-violet owing to its being a lesser evil. Accumulation of evidence that the infra-red may have harmful results has led to the demand for glasses which are also relatively opaque to all radiations except the visible, and at the same time reduce the brightness in the visible to a comfortable working level.

Added to these requirements is the demand on the part of metallurgical furnace workers that the color of the transmitted light be such that a satisfactory contrast between the melt and the furnace walls be present, else they are likely to remove the goggles at a critical time and experience the consequent deleterious effects. For such workers the bureau has developed a blue glass similar in color to the type which they prefer and at the same time opaque to the harmful ultra-violet radiation.

Methods of testing eye-protective glasses have also received much attention. It is necessary that the expense of testing be kept at a minimum consistent with effectiveness. Considerable time has been given to trying out short methods. The present standard is to use a gas-filled tungsten filament incandescent lamp in connection with a thermopile for determining the per cent transmission in the total visible and total infra-red; and for the ultra-violet substituting certain lines of a quartz mercury arc lamp, and thus determining the per cent transmission of the material for these lines. The following publication has been issued: "A nonactinic cobalt blue glass," by W. W. Coblentz and A. N. Finn (J. Am. Cer. Soc., vol. 9, p. 423; 1926).

A Spectrophotometric Analysis of the Lovibond Color System.—The Lovibond system of color grading is based on three sets of colored glasses—flashed cobalt blue, gold red, and silver yellow. The "tintometer" with these glasses is essentially a subtractive colorimeter in which adjustment to match is made by steps, instead of continuously as in a wedge instrument like the Eastman colorimeter (Jones). Each set of glasses comprises 20 "units" with numerous subdivisions. The glasses of a given set are intended to be "all of one color, but differing in depth, the divisions of difference (that is, the units) being equal throughout * * * The units * * * have also a color equivalence in relation to each other * * * accomplished when a normal white light can be gradually absorbed to extinction without the development of any color by successive additions of an equal number of units of red, yellow, and blue glass." (Advertising pamphlet of Tintometer (Ltd.), pp. 6–7.)

The grading of these glasses as found in actual sets is not as accurate as indicated by the numbers appearing on them. A spectrophotometric analysis of these glasses is an important step in the Bureau of Standards' investigation of methods of calibrating the glasses. Spectral transmission measurements were, therefore, made on the unit glasses of the bureau set from 1 to 20, inclusive over a range from 380 to 750 mμ.

It has been found that for all wave lengths which are of importance in the determination of the color of the glasses, whether yellow, red,

or blue, the following relation holds (except for the erratic variations above implied):

$$\text{Log } T = kN + a$$

where T is the transmission at a given wave length, N is the Lovibond unit from 1 to 20, and k and a are constants. This is the same relation as is found with wedges if N represents the thickness of the wedge or the distance measured from the hypothetical position of zero thickness.

Standard Artificial Sunlight for Colorimetric Purposes.—In 1918 (Phys. Rev. (2), 11, p. 502) Priest proposed the use of the rotatory dispersion filter for obtaining artificial noon sunlight from the gas-filled tungsten lamp at 15.6 lumens per watt (color temp. = 2,848°K). At that time this was a mere a priori proposal, untried in actual practice. Since then the filter has been constructed as proposed and has been in satisfactory service at the Bureau of Standards for some time. It is used as an integral part of the apparatus for determining dominant wave length and purity. (See J. O. S. A. and R. S. I., 8, p. 178.)

The filter consists of a crystalline quartz plate between "crossed nicols," the plate being 0.500 mm thick and placed so that the path of light is parallel to the optic axis. These parts are built in a cell which is inserted as a unit near the eye in the optical train of the colorimeter. The effect is that of a blue filter having a spectral transmission such that the spectral distribution of energy delivered to the observer's eye approximates very closely to average natural noon sun at Washington. The desired reproduction is much more precise than can be obtained by blue "daylight glass," dyed gelatin filters, or solutions of selective absorbents.

The Minimum Perceptible Colorimetric Purity as a Function of Dominant Wave Length with Sunlight as Neutral Standard.—In connection with the establishment of color standards, a knowledge of the minimum perceptible purity is important in order that the standards themselves be fixed with the requisite accuracy.

Method and Conditions.—A 4° square two-part field, symmetrical about a vertical division and viewed through a pupil 3 mm in diameter, is illuminated in both parts by artificial sunlight, at a constant brightness of about 3 or 4 millilamberts, with a surrounding field of about 0.5 millilambert. Homogeneous light is added to one-half and sunlight simultaneously subtracted so the field remains matched in brightness. We attempt to make two adjustments of the mixture: (1) The least purity perceptible with certainty (ρ_{max}); (2) The greatest imperceptible purity (ρ_{min}). Care being taken to correct for stray light, the purity of these mixtures is then measured, accuracy being obtained by measuring a known large multiple of the homogeneous brightness.

Results.—(1) For shortest wave lengths, the mean of ρ_{max} and ρ_{min} is very small (0.001 or less); (2) increases slowly to about 0.02 at 550 mμ; (3) rises rapidly to a sharp maximum at about 570 and falls still more rapidly to about 0.02 at 580; (4) there is then a gradual fall to less than 0.01 at 640 mμ beyond which we have no data. For Brickwedde the wave length of the maximum (precisely determined) is 568 mμ, the values for ρ_{max} and ρ_{min} being, respectively, 0.062 and 0.024. The corresponding wave length for Priest (less precisely determined) is probably greater but not more than 572 mμ.

Remarks.—1. Least perceptible purity is largely dependent upon visibility; the relative amounts of energy required to introduce a hue difference show comparatively small variation with wave length.

2. The wave length at which least perceptible purity with sunlight as neutral is a maximum approximates very closely to the dominant wave length of sunlight referred to equal energy spectrum as neutral. On the basis of the O. S. A. Colorimetry Committee "excitations" the latter wave length is 569.0 mμ.

3. Further extensive investigation of least perceptible purity should be prefaced by a definite adoption of a neutral standard.

Atomic Structure Investigation.—The existence of the 92 chemical elements presents one of the greatest problems on standardization confronting the physicist. Nature has constructed every atom of a given species in an exactly identical manner, but how or why the process is accomplished remains a mystery. Attempts to learn something of this standardization mechanism for submicroscopic entities lead to a widely varied field of experimental physics. Each detailed experiment contributes a little toward the final solution of the problem.

The discovery of a type of two-electrode tube which gives a large amplification factor of 100,000 or more for positive charges has made possible the investigation of ionization of atoms by light as illustrated by the curve for caesium vapor Figure 39. Two papers have been published on the photo-electric effect in caesium vapor and the general methods are being extended to other materials. Incidentally the photo-electric effect in caesium vapor offers one of the most sensitive methods for measuring ultra-violet radiation.

Most vapors are not directly ionized by the light transmitted through glass or quartz apparatus. To investigate the action of radiation on such gases a rather complicated tube has been designed inclosing the source of radiation, the gas upon which it operates, and the measuring device. Considerable data on higher critical potentials of several gases have been obtained in this manner.

Another type of electron tube involving crossed electric and magnetic fields has been applied to the investigation of the formation

of ions in vapors and gases. Very slow electrons are found to combine with certain vapor molecules forming molecular ions. If the velocity of the impacting electrons be somewhat greater, positive ions are formed. However, contrary to a prevailing theory, the splitting of a molecule into two molecular ions of opposite charge was not detected.

The mechanism by which atoms recombine to form molecules is being investigated by studying the radiation emitted in the process of recombination. In one series of experiments atomic hydrogen is produced by an intense electric discharge and is then pumped into the observation tube which contains a metal vapor. Spectra characteristic of the metal are thereby excited. Similar experiments have been completed by use of active nitrogen as the initial source of energy.

Illustrative of the varied lines of attack upon the problem of atomic structure, the following completed researches may be mentioned: Resonance radiation and the Doppler shift of scattered radiation, excitation of forbidden spectral lines, multiple electron transitions and primed spectral terms, polarization of radiation excited by electron impact, absorption probabilities, theory of the solid state, rate of decay of radium E, effect of electric fields on a photographic plate during exposure, quantum theory of light beats, photoionization in hydrogen, and fine structure of spectral lines.

Apparatus has been developed for investigating several properties of radioactive atoms. A large beta-ray spectrograph has been constructed by which the velocities of the electrons emitted, when an atom undergoes radioactive transmutation, may be accurately measured. From such data information is obtained relative to the wave lengths of the high-frequency gamma radiation which, by its photoelectric action, is responsible for the emission of the photoelectrons. Results for the element radium D have been published.

Publications.—"Fine structure and Zeeman effect of complex mercury lines," A. E. Ruark, Phil. Mag., **61,** p. 977; 1926.

"Polarization of radiation excited by electron impact," Ellett, Foote, and Mohler, Phys. Rev., **27,** p. 31; 1926.

"Photoionization and relative absorption probabilities of caesium vapor," Mohler, Foote, Chenault, Phys. Rev., **27,** p. 37; 1926.

"The natural beta-ray spectrum of Ra D," L. F. Curtiss, Phys. Rev., **27,** p. 257; 1926.

"The relation between metallurgy and atomic structure," P. D. Foote, Bull. A. I. M. E. E., Mining and Metallurgy, February, 1926.

"Note on decay of Ra E," L. F. Curtiss, Phys. Rev., **27,** p. 672; 1926.

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X-Ray Standardization.—Standardization in the field of X rays may be considered under three headings according as they are applied in medical science, physics, or industry.

The increasing use of X rays for diagnostic and thereapeutic purposes has made urgent the establishment of a unit of X radiation and the calibration of X-ray machines used in hospitals in terms of this unit in order to secure uniformity of treatment and reproducibility of results. The Bureau of Standards is now working in cooperation with the radiologists of the country for the establishment of such a unit. Another important matter in this connection is that of protecting operators and patients from the deleterious effects of exposure to strong X rays. Tests are continually being made by the Bureau of Standards on samples of lead glass and lead rubber which are sent by the manufacturers to have their protective value determined and thus standardize their product. An investigation on the protective properties of barium sulphate plaster was recently published, and another series of substitutes for sheets of metallic lead has been completed.

The more purely scientific aspects of X rays are being considered at the bureau from the point of view of standardization in the study of X-ray spectra and measurements of X-ray wave lengths. This phase of the work is significant, not only to provide accurate data for use in connection with the medical and industrial applications of X rays, but also because of its immediate bearing on the interpretation and extension of the recent revolutionary theories of the constitution of matter. In this connection the bureau is studying long wave length X rays with the aid of vacuum spectrometers.

The industrial applications of X rays are of ever-increasing scope and importance. These relate not only to the radiographing of commercial materials, such as weldings and castings, to detect flaws, but also the study of the composition and constitution of industrial materials, such as steels, alloys, and inorganic and organic chemicals. The bureau has recently installed an up-to-date, high-power radiographic equipment, and is prepared to undertake studies in this connection. For some time investigations have been under way, not only on alloys, pure metals, and inorganic substances, but also on organic materials.

Standardization of Methods of Carbohydrate Analysis.—In the present complexity of modern industrial life the necessity for standardization of methods of scientific procedure has attained a unique importance. This is largely due to the fact that a similar result must frequently be obtained by different workers in laboratories widely distributed geographically. The effort to make this thing possible has resulted in the formation of various scientific organizations, one of whose major purposes is the standardization of scientific methods. The bureau has cooperated to the fullest extent possible in furthering such purposes with regard to methods of analysis of carbohydrate products.

In connection with the control work carried on for the United States Customs Service the bureau has been engaged in investigations relating to the standardization of methods of analysis of sugar products. This has led to the adoption by the customs service of a number of methods developed at the bureau. In addition, work on standardization of methods of analysis is being carried out in collaboration with such organizations as the Association of Official Agricultural Chemists, the American Chemical Society, the American Feed Manufacturers Association, and others, as well as with individual manufacturers. This collaborative work has included the determination of sucrose by the Clerget method, analysis of beet and cane molasses, determination of moisture and ash in sugar products, and many others. The results thus far obtained have been of great value to industry.

Pure Sugars for Standardization.—Sucrose has been issued by the bureau as a standard sample for a number of years. It is widely used as a calorimetric standard in the analysis of coal on account of its high purity and its accurately known fuel value. It is also used as a saccharimetric standard, as a source of pure invert sugar for standardizing sugar analysis, and for other miscellaneous purposes.

Similarly dextrose (glucose) in highly purified form has been issued as a "reducing" sugar standard for use in sugar analysis.

Investigations are continually in progress with the view of increasing the purity of these sugars as well as the members of the rare-sugar group. Definite standardized products are urgently needed. At the present stage both sucrose and dextrose are prepared in highly purified forms with only minute quantities of impurities present. Repeated crystallizations under the most favorable conditions have failed to reduce these small amounts of impurities. In the case of sucrose there remains so-called reducing substances whose magnitude is less than 0.002 per cent. This apparent impurity may in reality be due to the chemical action of the sucrose itself in the course of analysis. The ash content of both sucrose and dextrose is less than 0.003 per cent.

Standardization of Polariscopes and Saccharimeters.—The polariscope or saccharimeter, which is used for testing sugar, makes use of the fact that a solution of sugar has the power of rotating the plane of polarization of a beam of plane polarized light, the rotation under standard conditions being directly proportional to the concentration or amount of sugar present. Inasmuch as practically all raw sugars, as well as many other sugar products, are bought and sold upon the basis of their purity as determined by polariscopic test, it is important not only that saccharimeters be accurately standardized, but also that all be standardized on the same basis. Additional emphasis must be placed upon the importance of the accuracy of this standardization by the fact that Congress prescribed that the import duties on sugars shall be based upon polariscopic test. An error of one-tenth of 1 per cent in the standardization of the instruments and the carrying out of the tests makes a difference of approximately $140,000 annually in the amount of revenue collected. In addition, it becomes a matter of the first importance to maintain the various large customs testing laboratories on a parity, so far as the accuracy of their work is concerned.

The bureau's research activities in this field have accordingly been directed along two major channels—the first, involving investigations to increase the accuracy of the basis of standardization, as well as the carrying out of the standardization itself; and the second, the maintaining of the laboratories of the various customs ports of entry on a parity as regards the accuracy of their tests on imported sugars. For many years the basis of standardization for the 100° point of the saccharimeter, accepted by the International Sugar Commission, was the value obtained by joint research of the Physikalische-Technische Reichsanstalt, and the Institut für Zucker-Industrie, in Germany, which resulted in the finding that the normal sugar solution reading 100° on the saccharimeter was equivalent to a rotation of 34.657 circular degrees for sodium light. An exhaustive investigation of this fundamental constant was made by the bureau which resulted in the discovery that the value was over one-tenth of 1 per cent too high, and that the 100° S point of the saccharimeter was actually equivalent to 34.620 circular degrees. As a result the producers of sugar received less than they were entitled to for their product and the United States Government was not collecting the full amount of duty prescribed by the Congress. The monetary consideration involved in this error amounted to vast sums. In addition, the results of much published scientific research work in which the saccharimeter was used were invalidated. The bureau is now standardizing all instruments and quartz control plates submitted for test on the corrected value, and the United States Customs Regulations now specify the corrected value in all customs work.

The sugar testing of the various customs testing laboratories is now being maintained for the first time on a fairly satisfactory parity by a check system of testing in which a sample of imported sugar is sent daily from each laboratory to the Bureau of Standards. Agreement of the tests between the importing laboratories and the bureau is successfully held within close limit. Continuous research in various aspects of this work is being carried on as rapidly as possible, and it is gratifying to note that recent investigations by European standardizing institutions have confirmed the bureau's discovery of the error in the 100° point prescribed by the International Sugar Commission.

The Development of a Standard Method of Levulose Production.— The general methods which have been employed in the preparation of levulose have consisted in the isolation of the sugar in the form of its condensation product, inulin, or in the form of an insoluble lime compound. Inulin has been converted to levulose by hydrolysis in the presence of dilute acids; and the lime compound has been decomposed, with the liberation of levulose, by the addition of suitable reagents such as sulphuric, oxalic, and carbonic acids. From the levulose sirups thus prepared the sugar has generally been induced to crystallize by the addition of nonaqueous solvents. Apparently in all of the experimental work which had been published previous to that undertaken by the bureau no critical study had ever been made to determine precisely the conditions under which the various reactions and operations are to be carried out most efficiently; hence there could be no standardized practice, and obviously no standard form of product. Harding's comprehensive history and discussion [6] of the art up to this time reveals nothing which reasonably could be adopted as a tentative standard of operation, performance, or product.

The bureau's systematic study of the reactions involved and of the operations thus indicated has already resulted in fairly definite standard methods of procedure and in fairly specific standards of performance for the laboratory and the small semicommercial scales of production. These methods have resulted in intermediates with fairly well-fixed standard properties which are subject to laboratory control; and a final end product of levulose crystallized from water without the use of nonaqueous solvents which is, in form, a standard granulated sugar. For further reference, see The preparation of levulose, Jackson, Silsbee, and Proffitt, 519; 1926. The development of this standardization of practice and of products has been related closely to the practices and products which have come to be considered standard in the established branches of the sucrose industry, with the object always in view of finally working out practical stand-

[6] Sugar, **25**, p. 406; 1923.

ards for commercial scale operations. Intensive work is now in progress for the further development of this phase of the project.

Development of a Standard Method for Matching Glazes and the Body Material.—The network of fine cracks often seen in the surface of glazed products not only mars the surface, but shortens the life and lowers the price of the ware. Since the relative expansivity of the glaze and body is a very important factor in controlling this condition, reliable measurements of both are of the utmost importance. Until recently the difficulty has been that the expansivity of the glaze has been measured on specimens of the material melted to glass and drawn into rods or cast in molds of sufficient length. Owing to the difference between this treatment and that received by the material when spread on the ware, it was realized that this method might lead to unavoidable errors.

By the interference method, specimens 0.2 mm in length can be measured with sufficient accuracy. Therefore, in measuring glazes the samples may be taken directly from the finished ware. In an investigation of this subject the thermal expansion of glaze materials prepared in the form of drawn glass or cast rods was compared with that of the same material taken from the finished ware. From the measurements the expected divergence was found to be as much as 20 per cent in the case of drawn-glass specimens and 10 per cent for cast specimens.

The comparisons prove that the specimens must be taken from the ware if reliable data are to be obtained. They also show that the expansions of the glaze and body must be nearly the same if stresses sufficient to produce crazing are to be avoided.

Photographic Lenses for Airplane Photography.—The rapid topographic surveying of large tracts of territory by the stereoscopic examination of airplane photographs is becoming more important, not only for its military values but in industry as well. For this purpose, the tolerances allowable in variation of focal length of the photographic lens and presence of distortion are much smaller than those applied by the manufacturer. Accordingly, such lenses must be obtained by selection and they must be standardized by having their focal lengths and distortion measured to a high degree of precision. New equipment has been installed which permits these measurements to be made readily and with great accuracy.

In addition, for enlarging the original photograph a method has been developed by which the distortion present in the best of lenses can be compensated by inserting a plane parallel plate of requisite thickness and refractive power back of the lens. Higher precision at much lower costs is thus attained. In many cases this plate may also serve as a ray filter.

Lens Design.—A handbook on The Application of the Algebraic Aberration Equations to Optical Design is in press. This is an extended treatment which sets forth a standard method of optical design. There has been much information published dealing with optical systems, but relatively little which describes the method of application of this information to lens design. Even this is scattered for the most part in scientific periodicals rather than collected in convenient book form. The algebraic aberration equations are approximate equations by which the first approach to the final design of an optical system is made. These equations and their application are treated fully and explained by illustrative examples in the pages referred to above. Appendixes giving useful mathematical tables to be used in optical design are included.

New Standards of Planeness.—The practical straight line is the straight edge formed by the intersection of two planes. The plane is, therefore, the basic standard of straightness as well as planeness. The fundamental test of planeness is that all planes will fit each other. Therefore, if each of three surfaces fits the other two at all orientations, all three must be plane. This furnishes a sufficient test for a standard plane.

The degree of precision with which a standard plane can be made depends upon the material, the skill of the artisan, and the accuracy with which a misfit can be detected. Fused quartz, which possesses only one-fifteenth the thermal expansion of glass and hence is much less likely to become warped by temperature irregularities due to handling, has become available in disks up to 11 inches in diameter. If it be permanent in form, it should be ideal material for standard flats.

Flats were made from three such disks about 10 inches in diameter and 1½ to 2 inches thick, which under test proved to be less than one one-hundredth of a light wave length (that is, less than 1/5,000,000 of an inch) off from a true plane at all points, exclusive of a narrow margin at the edge.

The following has been published: Making a standard of planeness, C. A. Skinner, General Electric Review.

Should these disks prove to be permanent in form, which time alone can reveal, the bureau will be provided with a permanent self-checking standard of planeness, having a precision which should prove entirely adequate for all demands.

Intermittency Effect in Photographic Exposures.—As a part of the bureau's work on standardization of sensitometry, a study was made of the effects of intermittent exposures. This investigation was prompted by data obtained some years ago which were not in agreement with the results of other investigators. It is the accepted view that, compared with a continuous exposure, intermittency always

causes a loss in photographic effect. A thorough investigation of these effects have been carried out, the results of which support and illuminate those from the earlier series of tests.

The intermittency effects were studied by comparing the differences in developed density between continuous exposures and intermittent exposures (the product of time and intensity in both cases being equal) made on adjacent parts of the same test plate. This procedure gave very good results, as the effects of unequal development and variations in the thickness of the emulsion layer are minimized and the photometric precision in density measurements are increased by observing only the differences and not the actual densities.

The effects studied included variations of intermittence (number of parts into which the exposure is divided), length of the rest periods between exposures, and illumination.

The most important fact brought out is that the intermittent exposures may, under certain conditions, exceed the nonintermittent exposures in photographic effectiveness. The magnitude and direction of the intermittency errors are found to vary with different emulsions, with the illumination, with the total exposure, the number of parts into which the exposure is divided, and the length of the rest periods between exposures.

When the illumination is above a certain level, dependent upon the particular emulsion, a greater photographic effect results from the intermittent exposures, and, conversely, for lower intensities a loss is obtained. The gain or loss, as the case may be, is accentuated by intermittence. The maximum effect appears to take place at the exposure value corresponding to the lower end of the straight-line portion of the characteristic curve. With certain values of illumination some emulsions show prominently both a gain and a loss. When this is the case, the maximum of one effect is at the lower end of the straight-line portion of the characteristic curve, and the other effect a maximum at the upper end.

The following analysis of the results is based on the conclusion that the latent image is modified by the simultaneous presence of two opposing influences, namely (1) a fading of the latent image after exposure and (2) a growth of the latent image after exposure. Both of these being distinctly accentuated by intermittence, but only slightly by long rest periods, indicate that the two actions are a maximum at the instant the exposure ceases and decrease rapidly from that time. The factors governing the magnitude and the rate of decay of these actions vary with the emulsion. The variation with illumination indicates that with a given intermittent exposure (1) a growth of the latent image results when the illumination exceeds

a certain value dependent upon the emulsion and (2) a fading of the latent image results when the illumination is less than this value.

The following has been published: Experimental Study of the Relation Between Intermittent and Nonintermittent Sector Wheel Photographic Exposures, by R. Davis. Sci. Paper No. 528.

CHEMISTRY

Distillation of Crude Cresylic Acid.—Under the tariff act of 1922, crude cresylic acid yielding as much as 5 per cent of tar acids distilling below 190° C. or as much as 75 per cent distilling below 215° C. is dutiable, while material yielding less tar acids is free of duty. The methods used in the different customs laboratories did not yield concordant results, so that the same material was sometimes taxed at one port and admitted free at another port.

At the request of the Director of Customs, Treasury Department, the bureau after investigating a number of methods developed a new method that provided for corrections for variations in atmospheric pressure, the use of thermometers calibrated for partial immersion, and determinations by weight. This method, with a few minor changes, has been adopted as standard by the Customs Service. See Treasury Decision 41735.

Determination of Chromium in Chrome Pigments.—Since specifications for certain chrome pigments, such as chrome green, prescribe a minimum permissible content of chromium, it is necessary to have an accurate method of determining chromium in such pigments. It was found both here and elsewhere that the peroxide method for this determination adopted by the Federal Specifications Board and the American Society for Testing Materials sometimes failed to give correct results. The necessary precautions for obtaining correct results by this method and also for obtaining accurate results by the persulphate method have been worked out. A paper entitled "A Study of the Peroxide and Persulphate Methods for Determining Chromium in Chrome Paint Pigments," by E. F. Hickson, will be published as a circular by the Paint Manufacturers Association of the United States.

Hiding Power of Paint.—Most purchasers of paint are primarily interested in the useful service that the paint will give in actual practice. However, lack of satisfactory means of defining and determining the important physical characteristics of paint makes it necessary to base standard specifications largely on chemical composition. Researches are, therefore, now being conducted with the ultimate aim of developing physical methods by means of which the pertinent properties may be directly specified and more satisfactorily tested.

One phase of this investigation has recently been completed, namely, the development of a method for measuring the hiding power of a paint. Paints may vary widely in their ability to obscure an underlying surface. Not only is good hiding power essential for pleasing appearance, but the hiding power is a ready criterion of the amount and quality of pigment employed in the formula.

The method devised by H. D. Bruce, and published in T306, for measuring the hiding power may be briefly summarized as follows: A disk, half black and half white, is coated with a thin film of paint. Through the thin film the white and black halves can still be distinguished, but their contrast has been greatly decreased by the presence of the paint coating. The degree of this contrast will be less the thicker the film and the greater the hiding power of the paint. An empirical relationship has been worked out so that, if the contrast is measured by means of a photometer and the film thickness by means of a gauge, from these two measured values the hiding power of the paint can be readily calculated. This hiding power is finally expressed in the number of square feet of surface that 1 gallon of paint will cover and hide.

Specifications.—Chemical work was carried out to furnish data to aid the Federal Specifications Board in formulating purchase specifications or standards of quality for materials to be used for cleaning purposes and for antifreeze solutions for automobile radiators. Data were furnished to assist the Interdepartmental Lime Conference and the A. S. T. M. in the preparation of specifications for the grades of lime used in various industries.

Detergent Value of Soap.—Although a number of investigators have reported methods to be used in evaluating the detergent power of soaps, no suitable, generally accepted laboratory test has been devised for measuring the performance of commercial detergents under the conditions that obtain in actual washing processes. During the past year the bureau, in cooperation with the detergents committee of the American Oil Chemists' Society, worked on a practical small-scale washing test with a view to setting up a performance standard for commercial soaps. Although progress was made, the work will have to be continued in an effort to improve the soiling technique and eliminate the personal factor. The progress report was published in the journal of the above-named society for 1926.

Absorption Spectrum of Dye Solutions.—It is a familiar fact that sunlight and artificial light are composed of light of the different colors of the spectrum. When white light falls on any substance, some of the colored rays are absorbed to a greater or less extent. The color of the substance is due to the rays which are not absorbed but which are reflected from it if it is opaque or pass through it if it is transparent. The color of the substance can be analyzed and

the amount and kind of light which is reflected or transmitted can be measured quite exactly by means of a spectrophotometer. The analysis and measurement of the color of dye solutions are useful in the identification of dyes and furnish a means of fundamental standardization and enable us to detect certain kinds of impurities because each colored substance has a characteristic "absorption spectrum." The method is used in the Bureau of Chemistry, Department of Agriculture, for identifying and ascertaining the purity of samples of dyes intended to be used in foods.

Commercial dyes are rarely pure, for reasons inherent in their method of manufacture, nor are they of full strength, but are diluted to a greater or less extent with inert matter. Before they can be identified and their strength measured in the way indicated, it is necessary to know their characteristics when of known purity and strength. For this reason numerous pure dyes were made and their absorption studied. The absorption spectrum may differ according to the liquid in which the dye is dissolved, and a solution when freshly prepared may not have the same spectrum after it has stood for a few hours. Also there may be several dyes which are the same in color to the eye but which are not alike in their chemical structure and therefore have different spectra.

The following papers have a direct bearing upon this problem of fundamental standardization:

"The effect of solvents on the absorption spectrum of a simple azo dye," W. R. Brode, J. Phys. Chem., **30**, p. 56; 1926.

"Standardization of agalma black 10B," W. D. Appel, W. R. Brode, and I. M. Welch, Indust. and Eng. Chem., **18**, p. 627; 1926.

"Subsidiary dyes in agalma black 10B," W. R. Brode, Indust. and Eng. Chem., **18**, p. 708; 1926.

"The absorption spectra of benzeneazobenzene," W. R. Brode, J. Am. Chem. Soc., **48**, p. 1877; 1926.

"The absorption spectra of certain monoazo dyes. I. The effect of position isomerism on the absorption spectra of methyl-substituted derivatives of benzeneazophenol," W. R. Brode. To appear as a Scientific Paper and, in abbreviated form, in Indust. and Eng. Chem.

"The spectral transmissive properties of dyes. II. Ten important textile dyes in the visible, ultra-violet, and infra-red," K. S. Gibson, F. K. Harris, and W. D. Appel.

Fastness of Dyed Fabrics.—There was close cooperation with the research committee of the American Association of Textile Chemists and Colorists for the purpose of standardizing methods for determining the fastness of dyed fabrics to light and to washing. A large number of washing tests were made, and some 12,000 samples were exposed to light under various conditions. The association had a research assistant at the bureau during the summer. There was similar cooperation along nearly the same lines with the joint committee on fast colors of the Converters' Association, the National

Association of Cotton Textile Merchants, and related organizations. They are attempting to clearly define the classes of fastness which are of interest to the trade, and to suggest a basis for an acceptable "trade practice," with the ultimate object of guaranteeing the color fastness of cotton fabrics. The Federal Trade Commission is much interested in what they are doing.

Standard Samples for Analysis.—In many industries the purchase of materials, process of manufacture, and sale of the manufactured product are controlled by analysis and by the use of instruments, such as pyrometers and saccharimeters. Oftentimes the analysis is difficult because of the chemical complexity of the substance under test and but little time is available for checking all steps of the method that is used. If an instrument of uncertain performance is used, defective products may result and thousands of dollars may be lost.

In such cases the simplest and at the same time the best safeguard lies in the use of standard samples. If, for example, a standard and a sample of the material under test are analyzed at the same time and under practically identical conditions, and results are obtained for the standard corresponding to those shown on the certificate, the presumption is strong that the figures obtained for the unknown material are equally accurate. Wide divergence from the certificate values shows at once something radically wrong, such as an improper method of analysis or faulty reagents. Thus, in the simplest possible manner and in the shortest possible time, a large number of variable factors have been simultaneously investigated with almost the same result as though each had been taken up separately.

Theoretically, there should be provided for the analyst as many standard samples as he has different kinds of material to deal with. It is obviously impossible to prepare and issue standard samples of all such materials. The Bureau of Standards has, however, endeavored to prepare samples that are representative of different groups, and such substances as are needed for the standardization of solutions and the calibration of instruments. The list now includes 69 samples of such diverse materials as limestone, feldspar, fluorspar, bauxite, phosphate rock, ores of molybdenum, zinc, manganese and iron, glass, cast irons, plain carbon steels such as basic and acid open hearth, Bessemer and electric, alloy steels, ferro-alloys, brass, bronzes, bearing metals, metals of certified melting points, cements for testing sieves, and chemicals for oxidation, reduction, acidimetric, saccharimetric and calorimetric values. The complete list, together with analyses, prices, and other information, is given in the supplement to C25, which can be obtained free of charge upon application to the Bureau of Standards.

The preparation of a standard sample is usually a laborious undertaking. From 300 to 1,200 pounds of material are used as the starting point. With steels and alloys care must be taken that ingots and castings are of uniform composition, that grains of proper size are obtained by machining and sieving, that the final sample is thoroughly mixed, and that proper methods of analysis are used by the analysts who participate in its standardization. Samples of ore weighing 300 to 500 pounds must be ground and mixed under conditions of chemical cleanliness. Most of the pure chemicals that serve as primary standards for various purposes are made or purified on a semiindustrial scale by the use of methods and apparatus that have been developed at the bureau.

During 1926, 18 standard samples were prepared and issued, of which 8 were new standards and 10 were renewals of exhausted standards. Of the new standards, No. 67 is a manganese metal, No. 68 a ferrotungsten, No. 69 a bauxite, No. 70 a feldspar, No. 71 a calcium molybdate, No. 72 a chrome molybdenum steel, No. 74a high-carbon cast-iron, and No. 80 a glass. The renewal samples are No. 7b, cast iron; Nos. 13c, 15b, and 16b, basic open-hearth steels; Nos. 20c and 35a acid open-hearth steels; Nos. 9c and 22b, Bessemer steels; No. 39c, benzoic acid; and No. 461, cement.

During the fiscal year 1925–26, 5,851 standard samples of a value of $12,283 were sold.

The kind and number of samples distributed were as follows:

Irons and steels	3, 379	Sodium oxalate	366
Ferro-alloys	190	Benzoic acid	629
Brass, bronze, and bearing metals	279	Naphthalene	76
Metals for melting points	138	Sucrose	86
Ores	238	Dextrose	39
Cements	431		

Of the valuation, $11,330.75 was received on domestic and foreign orders. The balance, $952.25, represents samples that were issued free of charge, of which State institutions and colleges received samples having a value of $549.75 and Government laboratories, $402.50.

The principal uses of the bureau's standard samples can be summarized as follows:

1. In checking methods of analysis and in standardizing solutions that are used in controlling the manufacture of certain metallurgical and agricultural products.

2. In the settling and avoiding of disputes between buyers and sellers. Such disputes very frequently arise through the selection of inappropriate or faulty methods of analysis by one of the chemists, and the analysis of a standard sample usually brings these to light before the case comes to court.

3. In standardizing calorimeters for gas and coal tests and polarimeters for sugar tests.

4. In standardizing pyrometers for use in the annealing of steels, alloy steels, and other metallurgical products.

5. For checking the sieving value of sieves used in the cement industry.

6. In investigating improved and more rapid methods of analysis.

7. In research work in educational institutions.

Research Bearing on Standardization.—Aluminum is an objectionable constituent in many nonferrous alloys, and numerous specifications either prohibit it entirely or else put very low limits on it. No satisfactory method has been available for the determination of minute amounts of aluminum in such materials. A study of the problem was, therefore, made and a satisfactory method has been developed by G. E. F. Lundell and H. B. Knowles (Ind. Eng. Chem., **18**, p. 60; 1926). By this procedure as little as 0.0005 per cent of aluminum can be determined in an hour, while 0.01 per cent can be easily detected in 10 minutes.

Analysis of Cast Iron.—At the request of the American Society for Testing Materials, Committee A-3, on cast-iron methods for the analysis of cast iron were prepared and accepted. These are intended to replace the present standard methods of the society and include methods for the determination of total carbon, graphite, manganese, phosphorus, sulphur, silicon, titanium, nickel, copper, and arsenic.

Analysis of Dental Gold Alloys.—Gold alloys are used for many kinds of dental work to provide materials which will not tarnish or corrode in the mouth. Most of these gold alloys must also have certain physical properties not often associated with the previous metals, notably stiffness, toughness, and elasticity. They should also be capable of taking a temper so that the desirable mechanical properties may be given to the alloy after it has been shaped. Several constituents are added to the gold to accomplish these purposes. Usually the alloys contain more than 50 per cent of gold, the remainder being silver, copper, and platinum or palladium, or both. Other base metals, such as tin, zinc, nickel, manganese, and magnesium, are often used in small quantities and occasionally the precious metal rhodium and iridium are also present.

The need for and possibilities of standardization in this field have been amply demonstrated by the work on physical properties of dental gold alloys. A necessary element in the standardization of these materials is a satisfactory method for the analysis of the alloys. The analysis of precious metal alloys is one of the most difficult fields of analytical chemistry and the dental-alloy industry as a whole has been greatly handicapped by the lack of adequate analytical methods. Work begun in 1924 by the bureau, in cooperation with the Wein-

stein Research Laboratories, on a complete procedure for the accurate analysis of gold alloys, such as are used in dentistry, was completed in 1926 and published as S532, "The Analysis of Dental Gold Alloys," by W. H. Swanger. Besides giving the detailed analytical procedure and the results of experimental work done in developing some of the separations, the paper contains a table showing the composition of 13 typical alloys. This work will be of material assistance in enabling manufacturers to control the composition of their alloys and in the necessary testing of materials on the market.

Specifications for Analytical Reagent Chemicals.—It is very important in all kinds of chemical work to have the chemical reagents used of a uniformly high standard or at least of some known standard of purity. The quality of reagent chemicals has always been a serious problem to chemists and the American Chemical Society for some years has had a standing committee on this subject. After long consideration this committee undertook to write specifications for all those chemicals in common use as analytical reagents, these specifications to set forth both the permissible limits of impurities and to prescribe the methods of test.

Specifications for 23 chemicals were published by the committee in the June and July, 1926, issues of Industrial and Engineering Chemistry and some 15 others will probably appear in the same journal late this year. These specifications, recommended as they are by the American Chemical Society, will be generally used as standards of quality for the materials in question. They are being put into use by reagent manufacturers as standards in their manufacturing processes. Thirteen similar specifications, published in 1925, already have been adopted by the General Supply Committee, and thus apply to purchases by the departments and independent establishments of the Government in Washington and certain branches of the field service.

The work of the bureau in this connection has been the critical study of many of the methods of test prescribed in the specifications. In some cases the limits of sensitiveness of existing methods were determined. In other cases proposed methods were modified or new methods provided.

Chromium Plating.—In the last two years there has been a great interest in chromium plating and its possible applications in industry. Such uses may include its application to printing plates, dies, gauges, gears, and cams, where its extreme hardness is advantageous; to reflectors because of its resistance to tarnish, and to automobile and plumbing fixtures. In 1925 an article by H. E. Haring, of the bureau, was published in Chemical and Metallurgical Engineering (**32**, 692; 1925), in which the use of chromium on the printing plates at the Bureau of Engraving and Printing was described. This proc-

ess, developed at the Bureau of Standards and described in LC177, is in successful operation, and has accomplished marked savings. Further research work is in progress at the bureau.

Measuring Polarization.—In electrodeposition the polarization—that is, the change in potential at an electrode during electrolysis—is an important factor in the structure, purity, and distribution of the metal. The customary methods of measuring polarization have been complicated and have been little used in industry. A new and simple method of measuring both the polarization and the resistivity has been devised and described in an article by H. E. Haring in volume 49 of the Transactions of the American Electrochemical Society. The method has been adopted by several metal refineries for controlling the content of addition agents in the baths.

Acid Zinc Plating Baths.—Zinc plating, or "electrogalvanizing," is used extensively for protecting iron and steel from corrosion, such as on tire rims, wire screen, and hardware. It is conducted either in alkaline cyanide solutions or acid zinc baths. The former have better "throwing power," but are more expensive and less stable than the acid baths. An extended study of the latter solutions showed that while it is not feasible to materially improve their throwing power, it is possible by large additions of sodium or ammonium chloride to greatly increase the conductivity and to use much higher current densities than have been customary. The results have been published in a paper by M. R. Thompson in volume 50 of the Transactions of the American Electrochemical Society, in the September, 1926, Monthly Review of the American Electroplaters Society, and in LC208.

Nickel Electrotyping.—A study of nickel electrotyping solutions, completed in 1925, was published in a circular on that subject by W. Blum and J. H. Winkler, distributed by the Electrotypers Association. In continuing this research a method for measuring the rate of covering graphite with nickel was developed and published by J. H. Winkler in the semiannual report of the International Association of Electrotypers, in September, 1926. Several papers of a series on "Principles of electrotyping," by W. Blum and J. H. Winkler, have been published in the Monthly Bulletin of this association.

Analytical Methods.—Continued cooperation with the Natural Gas Association has resulted in the development of tentative working standard methods for the determination of gasoline in natural gas. The bureau's part in this undertaking was the accurate analysis of a large number of gases to be used for the comparison of working methods. Apparatus was developed for the accurate measurement of very small volumes of liquid condensates, and for the more rapid

rectification of liquefied gases. A simplified form of the apparatus used here for the analytical separation of gases has been built by one large industrial organization and plans for the apparatus have been furnished to several others.

The development of an electrical method for determining carbon dioxide and oxygen in respired air for aid in physiological studies has been completed. The method will probably be adapted to the control of oxygen supplied to patients under hospital treatment to whatever standard concentration the attending physician may prescribe.

Service Standards in the Fuel-Gas Industry.—A study has been made and a paper prepared upon the effect of the large change of heating value standard in Denver. This change was the greatest ever made in the manufactured-gas industry and its results are of the utmost importance in determining the probable result of similar changes elsewhere. A summary of previous work on this subject was also published.

Publications.—"Relation of heating value of gas to its value to the user," by E. R. Weaver, Chem. Met. Eng., **33**, pp. 79–81; 1926.

Utilization of Gas.—The work upon the utilization of gas involves the determination of the essentials of good service, the determination of what standards of efficiency and safety it is reasonable to require of commercial appliances, the development of laboratory methods for the accurate determination of compliance with those standards, the actual testing of commercial appliances, and the recommendation of methods for improving appliances which are found to be inferior or defective. The bureau has taken an active part in all of these phases of the utilization problem during the year. The major work of the laboratory has been the thorough testing of a large number of space heaters and water heaters for the purpose of drafting reasonable specifications for commercial appliances of the two classes. These results have had immediate application in the preparation of approval requirements by the American Gas Association, with which the bureau has been in active cooperation.

Publications.—Causes of Some Accidents from Gas Appliances, by I. V. Brumbaugh. T303.

A Method for Testing Gas Appliances to Determine Their Safety from Producing Carbon Monoxide, by E. R. Weaver, J. H. Eiseman, and G. B. Shawn. T304.

MECHANICS AND SOUND

Standardization of Orifice Meters.—Since the orifice meter has come into general use in the gas industries, new investigations of its accuracy have been called for and the Bureau of Standards has participated in the following:

(*a*) Experiments by the American Gas Association, at Chicago, in 1923.

(*b*) Experiments by the Natural Gas Association of America, begun at Cleveland in 1925 and continued at Buffalo in 1926.

(*c*) Experiments by the bureau in cooperation with the Chemical Warfare Service, at Edgewood Arsenal, Md., during 1922–1925.

In (*a*) and (*b*) the bureau was represented on the directing committee and the observing staff, beside assisting by advice, testing of instruments, etc. An outline of (*c*) is given below. When the results of all three investigations have been compared, among themselves and with previous data, a comprehensive report on the whole subject will be prepared.

In the Edgewood experiments, air from a set of reciprocating compressors, after passing through an ammonia condenser and a tank of 400 cubic feet capacity, entered a line of 4, 6, and 8 inch pipes in series. An orifice flange was installed in each pipe size, with the necessary manometers, etc., so that three orifices could be tested at once. The damping by resistance and capacity was enough that no pulsations could be detected in the line.

The 8-inch pipe was followed by a 30-inch drum 30 feet long, with a nozzle and impact tube at the farther end for measuring the air as it escaped. The drum was provided with honeycombs for straightening the flow, and contained the wet and dry bulb psychrometer. The nozzles used were of 1¾ to 5 inches diameter, and for each one the distribution of air speed over the section was repeatedly determined at several rates of flow, by traverses with a fine impact tube. The rate of discharge of air through the nozzle could then be computed from the diameter, the reading of the central fixed impact tube, and data on the temperature, humidity, and barometric pressure.

Several hundred runs were made, each, in general, giving data on three orifices. The orifices were of various sizes, the range of differentials was large, and the static pressures were from near atmospheric up to 250 lbs./in.^{2} Omitting several subsidiary investigations, some of the results for square-edged concentric orifices may be given here in terms of the discharge coefficient C, computed by the "hydraulic" formula from the downstream static pressure, with the speed of approach factor included in C.

This is defined by the equation

$$W = 0.525\ Cd^2\sqrt{(p_1 - p_2)\rho}$$

in which W is the flow in lbs./sec.; d is the diameter of the orifice in inches; p_1 and p_2 are the absolute static pressures in lbs./in.^{2} at the upstream and downstream taps; and ρ is the density of air at p_2 and at the upstream temperature, in lbs./ft.^{3}

In agreement with previous investigations it was found that, over the range covered, the value of C depends on the ratios p_2/p_1 and

d/D (D=pipe diameter), but not on the absolute values of p_2 and d; it also depends on the location of the pressure taps. For taps 1 inch from the orifice plate, the most useful part of the results is given in the following table of values of C:

d/D=	0.0	0.2	0.3	0.4	0.5	0.6
p_2=1.00	0.602	0.604	0.607	0.615	0.632	0.664
p_1= .95	.607	.609	.612	.620	.637	.669
.90	.616	.617	.620	.628	.644	.677
.85	.625	.626	.629	.637	.654	.687
.80	.637	.638	.640	.648	.664	.698

These values were read from a set of curves adjusted so as to represent the whole mass of observations. They are believed to be correct within one-half per cent or better, but are subject to final revision.

Standardization of Methods of Testing Electric Fans.—For several years the Bureau of Standards has had occasion to measure the performance of desk electric fans for other departments of the Government and for the General Supply Committee. The input to the fan is a definite and easily measurable quantity, but there has been no standard measure of output or standard method of measurement. The bureau has, therefore, proceeded to compare various methods of measurement of the volume of air moved by the fan and to study the character of the air flow. As a result of this study the bureau suggested an easily measurable quantity, the thrust reaction, as the measure of output. From the value of the thrust, the volume can be computed within reasonable limits, and the energy output represented by flow of air parallel to the fan axis also, provided the form of the velocity distribution curve is known. Apparatus has been devised for measuring the thrust of fans quickly and accurately.

A number of manufacturers have requested that measurements be made at the bureau on sets of fan blades which may be used as standards for comparison purposes, and work of this nature will be carried out when requested.

Standardization of Wind-Tunnel Measurements.—The bureau, with many other laboratories of the world, has been concerned with the problem of standardizing wind-tunnel measurements, especially on models of airplane wings and airship hulls. One part of the work along this line consists of measurements on "standard" models which are circulated to wind tunnels throughout the world so that the order of magnitude of differences may be ascertained. This work is still in progress. Measurements have been made on two models of airship hulls and on one model of an airplane wing circulated by the National Physical Laboratory of Great Britain, and measurements are contemplated on a number of models circulated by the

National Advisory Committee for Aeronautics. Preliminary conferences have been held by the National Advisory Committee for Aeronautics and it has been found that there exist differences between the results of measurements in different wind tunnels too large to be attributed to differences in the method of measurement. There appear to be actual differences in the airs treams which cause differences in forces on the same model. These differences remain even when the effects of the diameter of the wind tunnel have been removed by the practical expedient of small models or by theoretical computation.

At the request and with the cooperation of the National Advisory Committee for Aeronautics, the bureau has been engaged in a study of methods of measuring the instantaneous speed, direction, and pressure of air streams. A satisfactory method of measuring static pressure at the wall of a wind tunnel has been devised, and in some instances correlation has been established between the pressure variations and the frequency with which a single propeller blade passes a fixed point. Work is in progress on the measurement of speed and direction. The chief result along this line has been to show that instruments involving the transmission of pressures through tubing give misleading results due to motions set up in the air columns in the connecting tubes.

Acoustics of Building Materials.—For the past two years measurements have been made at the Bureau of Standards of the transmission and absorption of sound by different materials commonly used in building construction. As a result it is now possible to assign to these different materials numbers representing their relative acoustic qualities.

A specially constructed building was erected for this work, one of the rooms being built so that there are no mechanical ties between its walls and those of the other parts of the building. This room is used as a transmitting room, and contains the source of sound (a loud speaker) which can be operated at any desired frequency and intensity by alternating current furnished by an oscillator set.

Between the transmitting room and the room adjoining (known as the receiving room) there is in the walls an opening 6 by 8 feet, in which is placed the panel whose sound transmission is to be measured.

The relative intensity of the sound in the transmitting and receiving rooms is measured by a telephone receiver. The emf set up in this receiver by the action of the sound waves upon the diaphragm is amplified until, when rectified, it will produce a deflection in a galvanometer. The input to the amplifier is then switched over to a potentiometer carrying a current of the same frequency as that used to produce the sound being measured, and the potentiometer adjusted to give the same galvanometer deflection as before. This

gives an emf which is proportional to the square root of the sound intensity.

The relative intensity of sound on the two sides of the panel is measured by placing the telephone first in the transmitting room and then in the receiving room. In both cases, the telephone is moved to a number of positions to obtain a representative mean value of the intensity.

Knowing the relative intensity of sound on the two sides of the panel, and knowing also the relative intensity in the two rooms when there is no panel in the opening, the fractional part of the sound energy cut off by the panel can be computed.

It is also possible to rate different materials according to their sound-absorbing properties, which determine the acoustic qualities of an auditorium in terms of the materials constituting its interior finish. This is done by using a brass tube of the proper size for the frequency at which it is wished to determine the absorption. A loud speaker is used as a source of sound and operated at the proper frequency to set up a standing wave system in the brass tube. The material whose absorption is to be measured is fastened to the end of the tube farthest from the loud speaker. If the material has no absorption, the standing wave system will consist of nodes and loops in which the nodes will be zero and the loops will have twice the amplitude of those of the down-going wave. If the material has some absorption, then the nodes will not be zero and the amplitude of the loops will not be twice the amplitude of those of the down-going wave. By measuring the relative intensity at the nodes and loops the absorption of the material at the end of the tube can be computed. The measuring is done as in the case of transmission except that a small tube is fastened to the telephone which acts as a probe and is inserted in the tube to which the test material is fastened. This probe tube must be small enough not to disturb materially the wave system in the larger tube.

Standardization of Sphygmomanometers.—Sphygmomanometers, or blood-pressure instruments, are used extensively in general medical practice as well as in the physical examination of military and naval aviators. In 1917, at the request of the Surgeon General of the Army, an investigation of several types of sphygmomanometers was undertaken at this bureau. Later, request was made by several manufacturers to recommend limits of error which should not be exceeded by the pressure gauges of the instruments when subjected to specified tests. These requests resulted in a thorough investigation, in the course of which information was secured from the heads of hospitals and medical schools and from physiologists as to the required accuracy in blood-pressure measurement. The infor-

mation received from these authorities, coupled with the results of the investigation of a large number of various types of instruments in the laboratory, were given due weight in specifying the tolerances.

The tolerance of both types of instruments are the same. The scale error at any point in any of the tests must not exceed 3 mm of mercury. The difference of pressure necessary to move the pointer or the mercury meniscus through any 30 mm interval must not be less than 27 nor more than 33 mm of mercury. Excessively irregular motion of the pointer or excessive sticking of the mercury column is considered a sufficient cause for the rejection of the instrument.

An informal report of a portion of the investigation of sphygmomanometers was issued in 1921 as Circular No. 51 of the aeronautic instruments section of this bureau. At the present time work is in progress on a report entitled "The Use and Testing of Sphygmomanometers," which will be published as a circular of this bureau.

United States Altimeter Calibration Standard.—In the infancy of aeronautics a standard atmosphere was adopted for the purpose of calibrating altimeters in which an assumption was made of a constant or isothermal air temperature of +10° C. This temperature assumption gave results which were sufficiently accurate in view of the low ceilings of aircraft at that time. For some years, however, it was well known that altimeters calibrated to this old isothermal atmosphere indicated altitudes which differed greatly from those determined by the relation in which average conditions of free air temperature were assumed. While this condition was recognized on all sides, it was felt inadvisable to change the basis of calibrating altimeters until a common standard could be adopted. In December, 1924, a conference was called by the National Advisory Committee for Aeronautics to consider the entire question and to secure unanimous action, if possible. The Bureau of Aeronautics of the United States Navy, the Air Corps of the United States Army, the National Advisory Committee for Aeronautics, the United States Weather Bureau, the National Aeronautic Association, and this bureau were represented. The technical work in connection with this conference was carried out by representatives of this bureau.

Altitude-pressure tables based on the new standard atmosphere were prepared at this bureau and issued as LC190, in December, 1925. The values of the altitude are given at intervals of 0.1 millimeter of mercury in the pressure range from 87 to 200 millimeters, at intervals of 0.2 millimeter of mercury in the range from 200 to 790 millimeters, and at intervals of 0.01 inch of mercury in the pressure range from 3.4 to 31 inches of mercury. The letter circular also includes a temperature correction table for use in evaluating the altitude as determined by both temperature and pressure measurements.

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This circular, with some revision, has been accepted during the present year for formal publication as a technical report of the National Advisory Committee for Aeronautics.

Specifications for Aircraft Instruments.—The number of instruments purchased by the air services of the United States Navy and Army after the war was far below current requirements, due to the considerable surplus on hand. This surplus is now either used up or consists of instruments too inferior for use. At the present time, therefore, instruments are being purchased in greater and greater quantity and variety.

It is obviously an advantage for the two air services to have common specifications in so far as their respective requirements permit. This fact was recognized and a conference was held in September, 1925, at McCook Field, Dayton, Ohio, by representatives of the engineering division of the Army Air Corps, Bureau of Aeronautics of the Navy, and the Bureau of Standards. The specifications of those aircraft instruments commonly designated service instruments were considered in detail at this conference. Since this conference this bureau has submitted revisions for the consideration of the military air services of the specifications for instruments or equipment under the following titles:

Flexible drive shafts and casings.
Gauge units, supercharger.
Fuel level gauges.
Indicators, bank and turn.
Indicators, flight.
Inclinometers.
Compasses, magnetic card type.
Manometers, mechanical type.
Oxygen regulators, Prouty type.
Oxygen regulators, manually operated.
Liquid oxygen containers, vacuum walled type.
Eight-day clocks.
Thermometers, vapor and liquid filled types.
Pressure gauges.
Airspeed indicators, Pitot-static type.
Thermometers, thermoelectric.
Altimeters.
Rate-of-climb indicators.
General specifications for aircraft instruments.
Tachometers, chronometric.
Manometers, liquid type.
Engine gauge units.

These revisions centered largely around the procedure of testing and the tolerances to be allowed for the various errors. The tolerances in many instances required an adjustment between accomplishments possible in production and the performance actually required in aeronautics. This adjustment was made in any par-

ticular case after investigational tests on a number of typical instruments of good quality.

The revisions furnished by this bureau have been incorporated in most instances into the specifications which are now used when purchases are made. This work represented an effort to standardize only in the light of the present stage of development of aircraft instruments. Further improvements in design and performance may be confidently expected, and therefore reconsideration of the specifications will be required periodically.

Brick Wall Investigation.—During the year 1926, the Bureau of Standards, in cooperation with the Common Brick Manufacturers Association of America, has been conducting a series of tests on brick masonry which from the size and number of test specimens and control and measurement of variables is noteworthy and unique.

While brick masonry is one of the oldest recorded types of construction, there has been a practical absence of data upon which to erect standards. To the lack of fundamental information can be ascribed the present unsatisfactory state of specification writing as applied to brick and the wide variation in building-code requirements concerning brick masonry.

The investigation may be considered as being divided into two sections. The first section consists of an investigation of the properties of individual bricks. These bricks are representative of four types of commercial production and are believed to be typical. Information gained from the results of this work has been already made use of by one of our national societies devoted to standardization. The second section consists in the construction and test of walls as hereinafter described. The results obtained from the individual tests correlated with the results obtained from the masonry tests give information directly applicable to the formulation of standards and specifications for brick. Description of the wall construction and tests follow.

The program consists of 153 walls, divided into four series. The variables consist of two types of workmanship, four kinds of clay brick, three kinds of mortar, and different types of construction covering 8 and 12 inch solid walls and the various 8 and 12 inch hollow walls used by the Common Brick Manufacturers Association. Tests on the association's 4-inch economy wall are also included.

The results secured from the tests on hollow walls of brick will be of interest with respect to answering the question as to whether the traditional solid masonry may not be in part replaced by a more economic utilization of the material.

The two types of workmanship have several distinctive features, the chief one being the practical absence of vertical joint filling for the walls in series 1 as against complete filling of joints in series 2, 3,

and 4. Series 1 was constructed by contract, to secure a grade of workmanship comparable to uninspected commercial work. Series 2, 3, and 4 are constructed by day labor with rather careful supervision. However, no laboratory refinements are introduced for the walls.

The mortars are a 1 : 3 lime-sand, a 1 : 1 : 6 lime-cement-sand, and a 1 : 3 cement-sand, all by volume, though the actual mixing is by weight, correction being made for the moisture content of the sand. In series 2, 3, and 4 an amount of hydrated lime equal to 10 per cent by volume of the cement is added to the 1 : 3 cement-sand mortar. It was originally intended to have the four grades of brick (one for each series) correspond to the four grades specified by the American Society for Testing Materials, viz, soft, medium, hard, and vitrified. On testing the brick it was found that they graded as follows:

Brick for—	A. S. T. M. grade in—		
	Compression	Modulus of rupture	Absorption
Series 1	Medium	Vitrified	Medium.
Series 2	do	Hard	Soft.
Series 3	Hard	do	Do.
Series 4	Vitrified	Vitrified	Hard.

In addition to the American Society for Testing Materials tests, additional tests were made for tensile strength and strength in shear, and for absorption without boiling and for rate of absorption.

The walls are 6 feet long by approximately 9 feet high, and of nominal thickness of 4, 8, and 12 inches, depending upon the type of construction. For each wall a corresponding small wall or wallette, 18 inches long by 34 inches high, is built. The walls are tested by loading concentrically to the maximum in the 10,000,000-pound compression machine. Strain measurements are taken both horizontally and vertically. On some walls readings are taken for repeated application of load.

At the time of writing the investigation is incomplete. Hence only the most general and obvious conclusions can be drawn: (1) Using brick of the same grade and the same construction, walls having all joints filled give greater strength than walls with open-joint work. (2) On solid walls, the stronger the mortar the greater the strength of the wall. (3) For solid walls the strength of the wall depends upon the strength of the brick; the stronger the brick the stronger the wall. (4) Uniformity in the size and the shape of the individual bricks has a bearing on wall strength. (5) The transverse strength of the brick has no definite relation to wall strength for any type of construction. (6) The ratio between the ultimate stress

(lb./in.^{2}) in the large walls and the wallettes is not constant for different types of construction.

Copper Roofing Investigation.—This investigation is being made at the request of and in cooperation with the Copper and Brass Research Association. Four major problems are in progress, including corrosion, corrugated sheets, soldered seams, and temperature effects on flat-seam roofing. The experimental work is about 75 per cent completed.

Accelerated tests and studies of failures are under way to determine the cause and find a remedy for a peculiar form of corrosion, rather infrequent in occurrence, affecting copper flashings. It appears probable that such failures can be avoided by slight changes in construction details. The pitting of soldered seams is also under investigation.

Copper in the form of corrugated sheets for roofing and siding may be used advantageously where other metals rapidly deteriorate and fail under exposure to severe weather conditions or other corrosive agents. As corrugated sheets are fastened directly to the roof purlins and no sheathing is used, it is necessary to determine the proper purlin spacing and a table of safe loads for corrugated copper sheets of various sizes of corrugations. An extensive series of loading tests for this purpose is nearly completed. The problem is complicated by the comparatively large increase in deflection which takes place if the sheets are left under continued load.

There are at present no standards of practice for soldered seams on flat-seam roofing. Comparative tests of seams are being made, the results of which are expected to form the basis for such standards. The factors under consideration are the type and size of seam, the amount and manner of application of the solder, and the kind of flux. So far results indicate that the type of seam most commonly used is quite inefficient. The flux affects the strength of the seam indirectly, poor flux causing imperfections in the soldering. If the edges of the sheets are tinned by dipping before delivery to the job, a much greater uniformity of workmanship is obtainable and with certain types of seam a considerable increase in strength.

Failures or partial failures of flat-seam copper roofing, such as splitting or buckling, may be ascribed to temperature changes. To provide the necessary data for tests, continuous records of the temperature of a copper roof at Washington, D. C., are being obtained. The maximum and minimum temperatures recorded are 147 and 10° F., respectively. The average daily range for May, 1926, was 63° F. Changes of 40° at the rate of 10° per minute have been observed. These data are being applied by testing roof panels 7 feet by 10 feet in size, where the effects of temperature, its rate of change and distribution, are being studied in relation to the construction of the roof.

The variables in construction include the size of the sheets, the type of seam, the type of fastening to the sheathing, and the workmanship. The object of these tests is to determine the most efficient and economical method of laying a flat-seam copper roof.

Joint Committee on Investigation of the Effect of Phosphorus and Sulphur in Steel.—This project was begun in 1920 at the initiative of the then existing United States Railroad Administration, the American Society for Testing Materials, and the Bureau of Standards, and has for its object the determination of the validity of and necessity for the limits placed upon phosphorus and sulphur in specifications for steel.

Representatives of the Bureau of Standards, War Department, Navy Department, American Society for Testing Materials, American Railway Association, Society of Automotive Engineers, Society of Naval Architects and Marine Engineers, National Research Council, Association of American Steel Manufacturers, Steel Founders' Society of America, and the American Foundrymen's Association make up the joint committee, of which Dr. G. K. Burgess, Director of the Bureau of Standards, has been chairman since its organization.

The complete program calls for the study of sulphur and phosphorus in steel of all ranges of carbon content. Phosphorus has not yet been studied, and so far only the work upon the effect of residual and added sulphur in rivet steel has been fully completed. This one phase of the investigation required over 5,400 tests, which were carried out in the laboratories of the Watertown Arsenal and the United States Naval Engineering Experiment Station. The plans called for check tests to be carried out at the Bureau of Standards in case of disagreement, but this has not been required owing to the close agreement of the results.

The program of and the progress reports on the work of the committee have appeared in the Transactions of the American Society for Testing Materials from 1920 on. Up to 1926 the committee recorded the data obtained, but drew no conclusions. Upon the completion of the rivet-steel work, the conclusion was arrived at that sulphur up to at least 0.06 per cent is not detrimental. Even at still higher sulphur contents many properties were not affected. The impact strength and transverse ductility were lowered somewhat as the sulphur was increased above 0.06 per cent. Shear strength of joints was not injured below about 0.08 per cent sulphur.

These conclusions were strengthened by the results so far of work in progress on other soft steels. The conclusions should not, however, by any means be taken as applying to harder steels, most certainly not to rail steels, spring steels, or any heat-treated steel, none of which have yet been studied by the committee.

While a revised A. S. T. M. rivet-steel specification has not yet been issued in which the sulphur limit is increased in accordance with the results of the work of the joint committee, and still stands (A. S. T. M. spec. A13–24) at 0.045 per cent sulphur,[7] the Federal Specifications Board master specifications Nos. 351 and 352 allow 0.070 per cent sulphur in rivet steel.

Statical Hysteresis in Bars.—The various types of elastic hysteresis have received considerable attention in the past. Elastic hysteresis as applied to the closed-load cycle may be defined as the difference in deflection of an elastic material at a given load when the material is subjected to a load cycle; that is, the load increased to a maximum and then decreased to the initial value. These phenomena are of importance in the cases of such instruments and apparatus as depend upon the elastic deformation of a spring, a diaphragm, or a combination of both. From the viewpoint of a designer of such instruments or apparatus very little exact information is available.

One type of elastic hysteresis, which may be called statical hysteresis, is invariant with regard to time. It specifically does not include the type of hysteresis considered by Boltzmann [8] in his well-known theory of "elastic afterworking," which may be referred to as hereditary hysteresis. Existence of statical hysteresis requires that the stress-strain diagram of a material for a closed-load cycle shall consist of a loop.[9]

The publication covering the work is entitled "Statical Hysteresis in the Flexure of Bars," by G. H. Kenlegan. T332.

Cast-iron Pipe Investigation.—The Bureau of Standards, at the request of the Consolidated Gas Co. of New York, made comparative tests on 6-inch cast-iron pipe which is being manufactured in France and on similar pipe manufactured in this country. It was desired to obtain information on comparative merits on different methods of testing cast-iron pipe, because the commonly accepted methods are considered unsatisfactory. The Consolidated Gas Co. supplied all the necessary material and prepared the specimens. The Bureau of Standards planned the program of investigation and made all the tests.

The French pipe was represented by the specimens obtained from one manufacturer and the American pipe was obtained from seven different foundries. The following tests were made: (1) Measurement of dimensions; (2) density; (3) chemical composition; (4) hardness; (5) transverse test—(*a*) machined coupons, (*b*) unmachined

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[7] The work of the joint committee is responsible for this liberalizing of the Federal Specifications Board specification over that formerly in commercial use.

[8] L. Boltzmann; Wien K. Akad. d. Wiss, Stiz., **70**, 1874; or Wissenschaftliche Abhandlungen von L. Boltzmann, **1**; p. 616.

[9] If hereditary hysteresis is absent, then the shape and the area of the closed loop is independent of the duration of the closed-load cycle.

coupons, (*c*) whole sections of pipes; (6) crushing test—(*a*) machined rings, (*b*) unmachined rings; (7) shearing test; (8) impact test; (9) hydrostatic test; and (10) metallographic examination.

The following conclusions were derived from the results of these tests: (1) The differences in the strengths of these cast irons were not great. The strength of French pipe was about equal to the average for the pipes of American manufacture. (2) There was a decided difference in the deflection; the French pipe had much smaller deflection than American pipe. (3) The brittleness of French pipe was evident from the lower impact values and from the suddenness of failure in the crushing and transverse tests. (4) The brittleness and the low deflection of the French pipe were probably due to its high phosphorous content (1.85 per cent, compared with an average of 0.64 per cent for American pipe). (5) Although no direct tests were made on the arbitration bars required by the American Gas Association specifications for cast-iron pipes, tests made on smaller specimens showed that the French pipe would, in all probability, not satisfy these specifications with regard to deflection. (6) Comparatively few defects were found in any of the cast irons. All the pipes were sound and complied with the American Gas Association specification for hydrostatic test. (7) On the basis of information which was obtained in these tests, practical suggestions are being given with regard to the testing of cast-iron pipe.

This paper is to be submitted as a Technologic Paper of the Bureau of Standards.

Compressive Strength of Column Web Plates and Wide Web Columns.—In connection with the design of the new suspension bridge spanning the Delaware River from Philadelphia to Camden, the joint commission of consulting engineers submitted for test 14 special I section plate and angle columns of a so-called silicon-manganese steel. In this test the over-all dimension and construction of all columns were identical, with the exception that the web thickness was changed. The web thickness varied from three-eighths inch plate to 1½ inches. Up to three-fourths inch in thickness they were single webs. The 1-inch thickness consisted of a series of two single webs and two one-half inch web plates stitch-riveted together. The 1½-inch web was composed of two three-fourths inch plates stitch-riveted. The principal object of the investigation was to determine the relative compressive strength of web plates, with particular reference to the ordinarily accepted design rule limiting the minimum thickness of plate permissible.

The investigation gave further information relative to the failure of a stiffened column section and the comparative action of single and double webs. In all tests the column section used to test the compressive section of the web plate was stiffened laterally by special

channel stiffeners applied to simulate the supporting conditions found in the actual tower construction of the bridge.

For further reference see Compressive Strength of Column Web Plates and Wide Web Columns, by Robert S. Johnson T327, 1926.

Methods of Socketing Manila Rope.—The tensile strength of a fiber rope, such as manila, sisal, or hemp, is an important property of the rope. Purchase specifications for fiber rope usually give the minimum breaking strength for each size of rope. In order to determine the strength of rope, the accepted procedure is to make an eye-splice in each end of a short length of rope and then test it in a testing machine. Because of the fact that a skilled workman is necessary to make a good eye-splice, and because of the large amount of rope used by this method, experiments have been made of other ways of fastening the ends of the rope.

Ropes having the ends socketed in plaster of Paris, Wood's metal, and a mixture of beeswax and rosin have been tested and the strength compared with that of rope having eye-splices in the ends.

Breaking Strength of Socketed Rope Compared to Spliced Rope.—These preliminary tests of socketing fiber rope for tensile tests show that breaking strengths can be obtained about 20 per cent greater than those for spliced specimens.

Effect of Size of Socket.—The sockets used for these tests were truncated cones with the large bases nearest to the end of the rope. Satisfactory results were obtained when the length of the socket was about 10 times the diameter of the rope, the diameter of the large base about seven times the rope diameter and of the smaller base about four times the rope diameter. It is evident that these sockets, which were designed for wire rope, were not necessarily of the most suitable dimensions for fiber rope. The tests on fiber rope having a diameter of 1 inch, however, indicate quite clearly that these dimensions could not be decreased very much without causing failure in the socket.

Preferable Socketing Materials.—Wood's metal was the most satisfactory socketing material. Next came plaster of Paris, preferably with the yarns of the rope coated with rosin, which appeared to increase the adhesion of the plaster. Both of these materials gave higher breaking loads than those for the spliced specimens. The rosin-beeswax mixture gave about the same breaking strength as the spliced specimen, perhaps because the rope failed in or near the socket. Alumina and asphaltic cements do not appear to be suitable socketing materials.

These tests show that a careful study of methods of fastening, particularly socketing, the ends of fiber rope for tensile tests is desirable. If sockets are used a fiber rope specimen need be only about 10 diameters longer than the free length. If socketed with Wood's

metal the breaking strength may be 20 per cent greater than that for spliced specimens.

A paper on the results of this investigation will appear in a technical periodical within a short time.

Holding Power of Wood Screws.—Tests on the holding power of over 10,000 flathead steel wood screws inserted in the side and end grain of seven kinds of wood, namely, yellow poplar, cypress, sycamore, North Carolina pine, Georgia pine, hard maple, and white oak, indicate: (*a*) That the size of lead hole is important and should be about 70 per cent of the core or root diameter of the screw, except in hardwoods, where the lead hole should be about 90 per cent of the core diameter of the screw. (*b*) That a lubricant, such as soap, may be used where necessary for easy insertion of wood screws without any great loss in holding power. (*c*) That for a given length of screw axially loaded the holding power increases with the diameter to a certain limit beyond which an increase in diameter decreases the holding power. (*d*) That for a given diameter of screw axially loaded the holding power increases with the length to the limit where the metal of the screw fails in tension. (*e*) That wood screws inserted in the end grain, where splitting can be avoided, should support about 75 per cent of the safe load computed for side-grain conditions. (*f*) That wood joints may be made much more efficient by selection of the proper size and number of wood screws.

The results of the above tests should form a basis for standard practices in the use of wood screws as a fastening device.

Publications.—Holding Power of Wood Screws, by I. J. Fairchild, T319; Furniture Manufacturer and Artisan, September, October, and November, 1926.

Finishes for Builders' Hardware.—Cooperative work with the manufacturers on the standardization of builders' hardware is being continued with special emphasis on establishing more nearly fundamental methods of measuring or specifying finishes. A number of the colors are now controlled by specifying the exact metal mixture which will produce a standard color; some are controlled by specifying the limit of purity, such as gold, silver, or nickel; and the remainder are being attacked with a view toward specifying the spectral reflection and colorimetric characteristics under standard conditions of illumination.

Vitreous China Plumbing Fixtures.—With the cooperation of the manufacturers, fairly complete nomenclature and definitions have been recommended for vitreous china plumbing fixtures which will eliminate much misunderstanding and controversy in the industry. Grading rules for staple items have been worked out limiting the character and number of blemishes acceptable for regular selection ware. The manufacturers state that grading rules have resulted in

an immediate improvement in the average quality of the ware through a closer control of manufacturing processes to avoid the penalty of blemishes which place ware in the "cull" classification. The nomenclature, definitions, grading rules, as well as the simplification of variety, approved by a general conference of producers, consumers, and distributers, will be published shortly as a simplified practice recommendation.

ORGANIC AND FIBROUS MATERIALS

Guayule Rubber.—In cooperation with the Continental Mexican Rubber Co., a study is being made of the properties of guayule rubber. By improved processes in the extraction of this material from the shrub, lots of crude rubber have been produced with properties approaching those of the plantation Hevea rubber. The use of guayule in place of Hevea rubber would prove of great economic value to the United States, as the shrub from which it is produced can be successfully grown in southwestern United States, California, and in Mexico.

Pilot Balloons.—The Department of Agriculture uses small balloons 10 to 16 inches in diameter to determine characteristics of wind and air currents. As a general thing these balloons will not remain afloat more than about 12 hours, which was not sufficient for the purpose for which they are used. Experiments with glue and glycerin coatings for the rubber showed that by dipping the balloons in a solution of glue and glycerin the permeability was considerably reduced, and that the balloons thus treated would then remain afloat two to three times as long as the untreated ones.

Endurance Machine for Testing Tires.—A machine for testing the durability of tires has been developed and checked against road tests. This machine now affords a method for testing tires which is much cheaper and quicker than a road test, and which can be carried out under definite, reproducible conditions. The test has been adopted as a part of the Federal specifications for tires. A complete description of the machine and test results of 230 cord tires are contained in T318, by P. L. Wormely and W. L. Holt.

Tensile Testing of Rubber.—Heat is generated when rubber is stretched. The resultant rise of temperature affects the strength of the rubber. This factor is overlooked in the usual routine testing of the tensile strength of rubber. The report by C. E. Boone and J. R. Newman was published in Journal of Industrial and Engineering Chemistry, May, 1926.

Reclaimed Rubber in Tires.—The recent high price of crude rubber has stimulated interest in the possibility of using reclaimed rubber in tires. T. 294, by P. L. Wormley and W. L. Holt, published late in 1925, called attention to some of the pitfalls to be avoided, with the

result that this year the industry has made real progress in the development of tire compounds of satisfactory quality which contain some reclaimed rubber.

Rubber Floor Tile.—Numerous tests have been made for prospective purchasers of rubber floor tile. These tests to date have all been strictly empirical, and can be regarded only as furnishing general information about the ordinary properties of the material. A special investigation will be required before any authoritative statement can be made on this subject.

Specifications For Balloon Tires.—Forty-five balloon tires have been tested on the endurance machine to collect data as the basis for a Federal specification. As a whole, the mileages obtained from these balloon tires have not been far different from those obtained from high-pressure tires. The method of failure was, however, in most cases different. Whereas failure due to separation is common in high-pressure tires, the breaking of the carcass was the principal cause for failure in balloon tires.

Rubber Substitutes.—The recent high price of crude rubber stimulated interest in the development of materials which might be used in its stead. The most obvious materials are reclaimed rubber and synthetic rubber. On the assumption that the inferior quality of reclaimed rubber is due to its physical structure, an effort is being made to improve this structure by coagulating a colloidal dispersion of reclaimed rubber in water. Synthetic rubber is being made in the laboratory by the polymerization of methyl isoprene, a process which takes some months.

Resilience of Cushion Tires.—The cushion tire is neither solid nor pneumatic. Its classification for taxation purposes has been raised in several States. A series of static deflection tests reported to the Rubber Association of America provided facts to be used in deciding this point.

Heat-retaining Properties of Laundered Cotton Blankets.—Apparatus had been designed and built, as described in two previous technologic papers, to measure the heat-retaining properties of textile materials. During the past year a study has been made of the effect of laundering upon the thermal insulating values of cotton blankets. The laundering was found to cause small losses in thermal resistance, ranging from 0 to 10 per cent, which were almost completely restored by the subsequent process for raising the nap on the laundered fabric. It is understood that this renapping process is used to a large extent by commercial launderies. The net losses in thermal resistance after four applications of washing and renapping processes were negligibly small, none being over 5 per cent. The results indicate the importance of a process for restoring the

nap after washing. Shrinkage was also observed to cause a counteracting gain in thermal resistance.

Rope-Yarn Bending.—The rope-bending apparatus described in Technologic Paper No. 300 has been used for testing the variables of the rope yarn. Samples of rope yarn having different grades of fiber, twists, sizes, and oil content were submitted by cordage manufacturers (through the Cordage Institute). An extensive study has been made of these, including, in addition to their resistance to bending, measurement of twist, size, oil content, and breaking strength. These results show logical groupings in regard to twist, size, and oil content; but thus far the attempts to differentiate between the different grades of fiber have been unsatisfactory, the results of some of the tests on the lower grades overlapping the higher grades. This would indicate that from the standpoint of bending fatigue there is no justification for the grade system now in use—a conclusion that will require further proof before it can be safely accepted.

Rayon Properties.—Research work on rayon aroused considerable interest in the industry, and numerous requests for additional information led the bureau to call a general conference on this subject, at which rayon manufacturers and representatives of various textile associations whose members were using this fabric were present. As a result of this conference, at which most of the phases of rayon research were set forth, the bureau began a study of the effect of moisture on the properties of rayon and the stability or resistance to aging. This project was started in May. The work has consisted chiefly of a search of the literature and some tests of samples that were available from preliminary investigations, the purpose being to fix a definite method of procedure for the general investigation.

Parachute Fabric Properties.—Various American manufacturers have endeavored to produce satisfactory parachute fabric in accordance with Government specifications. Twenty-six fabrics were examined during the year, of which seven were found to be satisfactory.

It has been found that the holes made in a parachute when it rubs against its shroud lines are caused partly by the rubbing itself and partly by actual burning resulting from heat generated by friction during the rubbing process. An apparatus has been designed and set up by means of which the resistance of a fabric to such abrasion and burning can be studied. It was found that all the fabrics tested were more or less susceptible to abrasion and burning under the conditions of this test, but it was found that dipping the cord in oil before test greatly decreased the possibility of abrasion or burning. It is recommended that various methods of treating the cord to cut down the abrasion and the heat generation be studied.

The presence of static electricity during the abrasion process was studied also, and it was found that although sufficient electric charge is present to deflect the leaves of an electroscope, in no case was it sufficient to make a spark.

Substitute for Silk Parachute Fabric.—The breaking strength of cotton yarns can be materially increased by treating them with cellulose ester dopes. Further increase in both strength and stretch can be achieved through a modified mercerization process. By combining the two treatments it is possible to produce a cotton yarn having many of the essential properties of silk yarns.

The final test of the material lies in the cloth, not in the yarn. Therefore apparatus has been installed to treat yarn on a semicommercial scale and then to weave it into cloth.

This work is being done in cooperation with the National Advisory Committee for Aeronautics and the Navy Department.

Hosiery Defects.—The research associate of the National Association of Hosiery and Underwear Manufacturers assists manufacturers with expert advice in case of trouble. Such advice is always based upon careful analysis of the individual problem. The solution is frequently of general interest to the industry, and is published in the semimonthly bulletin of the association.

Although some of these problems result from improper dyeing methods, it has been found that a large factor in streaky or irregular dyeing is nonuniformity in the raw material, such as variation in the denier or number of filaments of the silk, irregularities in the twist of cotton, etc. The introduction of rayon during the last few years into the manufacture of hosiery has presented many new difficulties. These range from actual mechanical difficulty in the handling of the product to chemical changes resulting from the addition of oil or its removal in the dye bath. The bureau has had many oral and written statements as to the value of this work, and has found that it is a primary feature in educating hosiery manufacturers regarding the value of technical research.

Size Standardization.—The bureau has in progress several projects that will permit the adoption of standard methods of measuring and standard sizes for the garments manufactured by members of cooperating associations.

Standard lengths of hosiery have been set up this year and have been adopted by the National Association of Hosiery and Underwear Manufacturers.

The Associated Knit Underwear Manufacturers of America have been cooperating with the bureau in the problem of fixing standard sizes for men's, women's, and children's knit underwear. Standard sizes have been adopted for men's, boys', and children's ribbed and flat-knit cotton union suits; men's worsted and worsted-merino and

wool and wool-cotton mixed union suits (1×1 rib); men's ribbed cotton two-piece underwear (1×1 rib); men's flat-knit cotton two-piece underwear; and men's flat-knit wool and wool-cotton two-piece underwear. Further work is being done on the remaining types.

The underwear association is attempting to standardize sizes of boxes and containers. An added feature of this work is the endeavor to work out dimensions for the containers in which underwear is sent to the trade, so that they may reuse the boxes in which the underwear yarn is shipped. This feature will accomplish a very large saving if successful.

The National Knitted Outerwear Association has recently established a research associateship to do work along similar lines for that industry. One tentative proposal has been submitted for shaker sweaters. Another is in progress for bathing suits.

Effect of Dry Cleaning on Silk.—The study of tin-weighted and unweighted samples of silk after various treatments and exposures to sunlight and storage at standard conditions (of 65 per cent relative humidity at 70° F. temperature) permits the following conclusions: (1) No deterioration results from exposures to standard atmospheric conditions over a period of 2½ months, even when acid or alkaline perspirations are applied. (2) Sunlight exposure caused a marked deterioration in both unweighted (but dyed) and tin-weighted silks, the loss in strength in 100 hours' exposure amounting to about 25 per cent for unweighted and about 50 to 75 per cent for weighted silks. (3) Acid and alkaline perspiration treatments increase the deterioration when sunlight exposures are given, so that the loss in strength in 100 hours' exposure is about 35 per cent for unweighted and about 65 to 100 per cent for weighted silk. (4) Dry-cleaning solvents in no case caused any appreciable deterioration of the silk fabrics.

It is to be noted that the "100 hours" mentioned above is the time exposed to direct sunlight—a condition which, in ordinary service, would require a year or two to fulfill. This work was done in cooperation with the National Association of Dyers and Cleaners.

Development of Cleaning Processes.—The dyeing and cleaning industry, through their national association, has been studying the numerous troubles that are encountered in the dry cleaning of garments and other materials. The almost countless number of stains that may be found on garments in ordinary service, added to the variety of fibers in use and the methods of dyeing and finishing them, cause the dry cleaner a great deal of difficulty. For example, it is estimated that there are over 1,500 different kinds of inks used by the American people. To remove these from even the common textile fibers, such as cotton, wool, silk, and linen, is a task that requires highly technical skill.

The results of these studies are published monthly in the technical news bulletin of the National Association of Dyers and Cleaners.

Cleaning of Furs and Leathers.—A preliminary report covering the work on cleaning of furs and leathers has been prepared and submitted to the National Association of Dyers and Cleaners. This report covers the cleaning materials used and the substances added to preserve the pliability of the leather, and includes methods for cleaning, a process for placing fat-liquor in furs, and machine and hand methods for dry-cleaning dyed leather.

Standard Grades of Wool.—After some years of trial, it was decided that the official seven grades of wool did not offer sufficient refinement to meet the needs of the industry. It was necessary to grade the wool more closely, and consequently establish a larger number of grades. In view of the international market for wool, there were obvious advantages to be gained by adopting the 12 grades in use in England, together with the British names for them.

Standard samples of each of the 12 grades of both raw wool and tops have been set up by agreement between the Department of Agriculture, Department of Commerce, the National Association of Wool Manufacturers, and the British Wool Federation. These have been promulgated as official United States standards by the Secretary of Agriculture.

Moisture Content of Cotton Yarns.—Some tests were made to determine the moisture content of carded yarns, combed yarns, and mercerized yarns at standard humidity conditions. These yarns were the kind most commonly used in the hosiery industry, and it was at the request of the National Association of Hosiery and Underwear Manufacturers that the project was undertaken. The results will be used as a basis for purchase in connection with their standard contract form.

Air-conditioned Testing Cabinet.—Paper is hygroscopic, and as its physical properties are considerably affected by its moisture content, strength tests and other physical tests must be made under definite hygrometric conditions. As apparatus for maintaining these conditions in the usual laboratory testing room is quite expensive, most of the industrial laboratories lack such equipment. To assist in remedying this situation an inexpensive air-conditioned testing cabinet has been developed. The testing instrument is placed inside the cabinet, and the test specimens are handled by means of long-sleeved rubber gloves fastened to apertures in the cabinet, this obviating the necessity for exposing the interior of the cabinet to the surrounding atmosphere. A constant relative humidity is maintained in the cabinet by circulating the air through a solution of sulphuric acid, the relative vapor pressure of which is determined by its density. Details of the cabinet and some results obtained with it are given in

a paper presented by F. T. Carson at the February, 1926, convention of the Technical Association of the Pulp and Paper Industry and published in the association papers, June, 1926.

Tensile Strength Testers.—In further study of the tensile strength testers, additional comparative test data have been obtained with six commercial instruments. Two of these are the small portable type especially adapted to making tests in the field. Some of the others were instruments that had been improved in design since previous tests were made. It was found, as before, that concordant test results were obtained with different instruments of the swinging arm or pendulum type. A type in which the force required to break the test strip was indicated as pressure within an ordinary hydraulic cylinder by means of a Bourdon tube pressure gauge gave appreciably lower results than the pendulum type. The portable instruments showed fair agreement with similar types of the larger laboratory instruments. The results of this study led to specification of the pendulum type of instrument by the Technical Association of the Pulp and Paper Industry in its official method for determining the tensile strength of paper.

Measurement of Degree of Sizing of Paper.—Thirty-eight methods proposed by various investigators for measuring the rate at which paper absorbs aqueous liquids, relative to its degree of sizing, have been listed and briefly described for the first time in one publication. These methods have been critically examined, classified, and compared experimentally. Stress is laid on the essential difference between the degree of surface sizing and the degree of internal sizing, the paper dealing with the latter only. The lack of concordance of the various methods has been traced to the influence of selective absorption from solution and of an extraneous resistivity. A test of the rate at which water penetrates into paper is considered the most logical and useful method of measurement. This conclusion was confirmed by the results of tests using methods of this type developed at the bureau compared with other types of sizing tests commonly employed. For further details see Measurement of the Degree of Sizing of Paper, by F. T. Carson T326.

Wet-Rub Tester.—In connection with research on currency paper, it was necessary to find a means of determining the resistance of the paper to surface abrasion. A test for determining this property is commonly made by rubbing the paper with a moistened finger and noting the resistance of the surface of the paper to disintegration. A machine was developed which gives a numerical measure of this property, and with which excellent results in respect to reproducibility have been obtained.

Waterproofed Case-lining Paper.—Investigation of waterproofed case-lining papers was made at the request of the Bureau of Foreign

and Domestic Commerce to develop information to aid overseas shippers in their selection of such papers. The type found most suitable was duplex asphalted kraft paper. As existing methods of testing the water resistance of such paper were found inadequate, research was made to find a suitable method of test. This resulted in the development of the "ground-glass" method, which is considered satisfactory for this purpose. Specifications of water resistance, strength, and weight were formulated, which are believed to define paper of suitable quality. The results are reported in T312, A Study of Test Methods for the Purpose of Developing Standard Specifications for Waterproofed Case-lining Paper, by B. W. Scribner and F. T. Carson.

Windows of Window Envelopes.—The use of window envelopes has become extensive, owing to the economy in labor and time effected by them. This widespread use is a matter of concern to postal authorities and postal clerks, as windows of inferior quality cause delay in handling mail, and considerable eyestrain on the part of postal clerks. For these reasons the bureau is collecting data to assist in establishing standard specifications of quality for the windows.

The main requisites of windows are high transparency or its converse, low opacity, and low gloss, as deficiency in either respect makes the reading of the address more difficult. With the cooperation of manufacturers, representative samples of practically all domestic window envelopes were secured and the windows tested for opacity and gloss. Transparency was determined with the bureau apparatus described in C63. The Ingersoll glarimeter was used for measurement of gloss. Windows having opacity not greater than 0.20 contrast ratio and gloss not exceeding 80 per cent are satisfactory. A technologic paper reporting the results is in preparation.

Bamboo Pulp.—Study was made on a laboratory scale of a sample of unbleached bamboo pulp received through the Bureau of Foreign and Domestic Commerce from a mill in the Philippine Islands. The details given as to the manufacture were: The bamboo is cut into lengths from 1½ to 2 feet and the joints removed. These lengths are crushed between rollers and cooked in a 20 per cent soda solution. The fibers were found to have the following mean dimensions: Length, 2.62 mm; diameter, 0.017 mm. The best paper-making results were obtained with a rather mild beating treatment. The strength of the bamboo paper compared well with that of strong sulphite pulp. It was concluded that the pulp would be suitable for such papers as wrapping or board.

Waste Fiber from Manila Rope Manufacture.—The results of laboratory paper-making tests of waste fiber from the manufacture of manila rope indicate that this material may be employed profit-

ably for paper making. The tests were made on samples submitted by the Navy Department from its Boston Navy Yard rope manufacturing plant. Around 200,000 pounds of the material are available annually. The waste fiber is very fine and bulky and contains 14 per cent of oils, these being derived from the oils used in the rope-making process. It was pulped, as received, with various alkaline chemicals. The best appearing paper was secured by the use of caustic soda. This process gave a pulp yield of 35 per cent. The paper was suitable for wrapping, comparing favorably with sulphite manila wrapping in strength. Much better results would no doubt be obtained by extraction of the oils before pulping.

Caroá Fiber.—Semicommercial paper-making tests of caroá fiber from Brazil have confirmed the excellent laboratory results previously reported. (Caroá fiber as a paper-making material, Paper Trade Journal, Shaw and Bicking, Jan. 8, 1925.) The yield of pulp obtained from the shredded material is around 50 per cent, using caustic soda as the reducing agent. In the character of the paper-making processes required and in its strength and other properties caroá fiber paper closely resembles high-grade rag fiber paper. Papers made from pulps produced by various modifications of the pulping process ranged in bursting strength from 50 to 60 points, and in folding endurance from 1,800 to 3,900 double folds, for 60-pound paper (basis, 500 sheets, 25 by 40 inches). These results are of particular interest in view of the increasing scarcity of paper-making rags. Information at hand indicates that with sufficient demand, caroá fiber could be obtained in ample amount for paper-making purposes, and at a cost that would allow it to compete with paper-making rags.

United States Paper Currency.—Research on United States paper currency was instituted for the purpose of improving its quality and fixing standards of quality and of the processes for obtaining them. This work is being done in cooperation with the Treasury Department, the Bureau of Efficiency, and the manufacturer.

The main problem relates to wearing quality, as the life of the paper currency had decreased to about one-third of its former life, causing excessive expenditures for replacement. The paper-manufacturing processes are being studied on a semicommercial scale in the bureau paper mill. Modification of the nature of the beating treatment of the paper fiber resulted in a marked improvement in the strength of the currency paper. By brushing out the fibers well and leaving them long, paper of satisfactory printing quality and having over double the strength of the paper in use was produced. The manufacturer applied this semicommercial result to commercial mill practice with satisfactory results. Another line of research being followed deals with the surface sizing of the printed currency.

It was found that increased resistance to surface wear could be obtained by hardening the glue sizing being used, by after-treatment with formaldehyde.

The work consummated has enabled the Treasury Department to so revise the technical requirements of its currency paper specifications as to provide for paper of more than double the strength previously specified, and such paper is now being obtained with no increase in cost. The following publications will give details of this research:

Research on the Production of Currency Paper in the Bureau of Standards Paper Mill, by M. B. Shaw and G. W. Bicking. T329.

"The glue surface sizing of paper," by G. K. Hamill, V. H. Gottschalk, and G. W. Bicking, to be published in Paper Trade Journal.

Use of Glue in Coating Paper.—As a summary of the research work in collaboration with the National Association of Glue Manufacturers, a demonstration of the use of glue in coated paper was given to representatives of the glue and paper industries. Using formulas that had been evolved for use at room temperatures with the semicommercial equipment available, four lots of paper were coated. Three widely different grades of glue were used, and one lot was made with casein for comparison. On the third day of the demonstration, samples of the papers coated were printed in the halftone pressroom of the Government Printing Office.

This research has shown that variations in the type of stock coated, the materials entering into, and the method of preparing coating mixtures, equipment, and working conditions of the coating, drying, and finishing operations, influence the appearance of the finished coated paper and the amount and proportion of adhesive required to obtain a coated paper of satisfactory printing qualities. Variations in inks and in printing conditions and practice have been noted as affecting strongly the tendency of coated papers to pick or lift during the printing operation. It was also indicated that with proper selection of the glue used and adaptations to local conditions and product requirements the use of glue in coating paper requires little change in equipment or operating technique from procedure with casein; and that except possibly in some lithographic or off-set processes where an extraordinary degree of waterproofness is required, the use of glue-bound paper offers no new difficulties to the printer. (The Use of Glue in Coated Paper, by G. K. Hamill, V. H. Gottschalk, and G. W. Bicking. T323.)

Strength of Kraft Wrapping Papers.—The use of kraft wrapping papers is increasing rapidly, due to their great strength and relatively long life as compared with many other types of wrapping papers. There is lack of adequate strength data for this type of paper, and as

strength is one of its main requirements such data are being secured to assist in formulating strength specifications. All four commonly applied strength tests—bursting, tearing, breaking, and folding—are being applied. Practically all representative domestic products have been tested, and samples of foreign papers secured through the foreign representatives of the Bureau of Foreign and Domestic Commerce are being tested as rapidly as the papers are received. The results so far obtained show, in general, little difference between foreign and domestic papers of the same grade. There is wide variation in strength, the weakest papers being around one-fifth as strong as the strongest. The bursting, folding, and tensile test results show fairly good agreement with each other as regards ranking the papers according to strength, but the tearing test shows no consistent agreement with any of the other tests applied.

Opacity of Paper.—Results obtained in continued use of the Bureau of Standards opacity tester, described in C63, show that this is a very accurate and practical means of measuring the opacity of paper. It has been used extensively in bureau investigative work on thin book papers, envelopes, and the windows of window envelopes. As it is used by several industrial concerns a number of check tests of results obtained with different instruments and different operators have been made. The agreement in such case has been found to be within 1 per cent of the total reading. Scale settings of an instrument can be repeated for any two given areas of a test specimen to this same degree of accuracy. In the case of thin book papers, the showing through of printing was found to accord with their opacity values. The use of this instrument was specified in Government stamped envelope specifications, and it has been found satisfactory for this purpose. It is also specified in the tentative specifications suggested for the windows of window envelopes.

Synthetic Tanning Materials.—Materials derived from coal-tar crudes are being slowly developed for use in the tanning of hides. During the year T302, "Investigation of Synthetic Tanning Materials," by Edward Wolesensky, was issued. This report describes experiments in which products were produced from various coal-tar crudes and examined for tanning properties. Thus a fairly complete survey of this field has been furnished the industry, together with methods of manufacture and classification of those products which yield materials with tanning properties and those which do not. The products obtained by condensing the sulphonic acids of the monohydroxy phenols with formaldehyde possess true tanning properties as do the products obtained from the phenol or cresol formaldehyde resins. The results of tanning tests showed that many of the products were suitable for tanning light leather which was pliable and strong. No product was found which could be considered a satisfactory sub-

stitute for the vegetable materials used in producing heavy leather because of the lack of filling properties characteristic of the latter.

Sulphite Cellulose Extracts for Tanning.—Considerable progress has been made in the studies of the suitability of sulphite cellulose extracts for use in the actual tanning processes. These extracts are prepared from the unlimited supply of waste liquors run off in paper pulp mills.

According to the hide powder method of determining tannins in materials, these extracts contain amounts comparing favorably with those found in some of the natural tanning materials, as shown below:

Extract	Per cent of tannin (A. L. C. A. method)
Sulphite cellulose No. 1	28.33
Sulphite cellulose No. 2	28.79
Sulphite cellulose No. 3	22.74
Sulphite cellulose No. 4	24.90
Chestnut wood	27.33
Oak bark	24.92
Hemlock bark	27.45
Sulphited quebracho	36.60

Tanning experiments on hide powder and calfskins showed these extracts to possess undoubted tanning properties. Like some of the syntans from coal-tar crudes, these extracts possess the property of converting a portion of the insolubles in quebracho extract.

Whereas leather can be made using these extracts alone, it does not compare favorably in weight and firmness with commercial leathers. Satisfactory leather can be obtained by blending these extracts with the ordinary ones. Tanning experiments in the laboratory with a blend of one-third sulphite cellulose, one-third chestnut wood, and one-third cutch extracts, gave leather satisfactory as to color, chemical, and physical properties. The average degree of tannage for 10 lots was 68, the yield 72, and the tensile strength of the rough, uncurried leather, 3,300 pounds per square inch.

It is concluded that these materials may be economically used for tanning heavy leathers.

Chrome Sole Leather.—Research to establish the relation between chrome and vegetable tanned sole leathers with respect to durability, is described in T286, "The Comparative Durability of Chrome and Vegetable Tanned Sole Leathers," by R. C. Bowker and M. N. V. Geib. In general, the results showed that natural and paraffin-filled chrome sole leathers wore twice as long as vegetable-tanned leather. When other filling materials are incorporated in the chrome leather in order to secure firmness and water resistance, the ratio of increased wear is lessened roughly in proportion to the amount of material added. This standardization of the properties of chrome

sole leather has stimulated commercial production and experiment on this type of leather.

Composition Soles.—During the year standard methods for evaluating composition shoe soles have been inaugurated with some apparent success. The properties measured are as follows: Thickness, density, tensile strength, elongation, and resistance to abrasion on the original soles. The soles are then aged in an electric oven for 14 days at 70° C. and the strength, elongation, and abrasion resistance again determined. The abrasion tests are made on the apparatus described in T147 by R. W. Hart and R. C. Bowker.

METALLURGY

Recommended Procedure in Conducting Corrosion Tests.—In cooperation with the committee of the American Society for Testing Materials on the corrosion of nonferrous metals and alloys, a very comprehensive series of laboratory tests has been carried out during the past two years to determine the relative corrodibility of a set of typical metals by various solutions when applied under different conditions. The laboratory work has been completed, and on the basis of the results obtained recommendations as to the proper procedure in carrying out the "total immersion," the "repeated immersion," the "spray," and the "accelerated electrolytic" corrosion tests will be drawn up. The results obtained clearly illustrate the difference in the corrodibilty of a metal with the same solution according to the corrosion conditions which obtain and serve to emphasize the need for standard practice in carrying out corrosion tests.

Work merely following the outlines laid down by the committee for electrolytic testing was not adequate to show the possibilities and limitations of that method. Since a majority of the students of corrosion believe it to be best explained by the electrochemical theory, electrochemical methods of test deserve further attention. The bureau is therefore now following, in cooperation with the electrochemical section of the chemistry division, a program of its own of further study of electrolytic corrosion test methods.

Similar extended tests on zinc-coated (galvanized) sheet material are now in progress for subcommittees of the committee on corrosion of iron and steel of the American Society for Testing Materials. The accelerated laboratory tests are carried out on a variety of zinc-coated materials which are also being used in the committee's comprehensive series of exposure tests. When both series of tests are complete, a correlation of the results of relatively rapid laboratory tests and of those of exposure or simulated service extending over many years, will be possible. The usefulness or uselessness of these laboratory tests in specifications can then be demonstrated.

While these corrosion projects are very extensive, requiring a huge number of tests and a continued program of study for several years, the need of rapid, cheap, reproducible, and dependable methods of predicting the resistance of metals and alloys to corrosion is so great and the subject so complex that comprehensive work is the only kind worth while.

Publications.—Report, Subcommittee VII of A–5, A. S. T. M. Accelerated corrosion tests for coated metals, Proc. A. S. T. M., **26** pt. 1; 1926.

Note on protection of iron by cadmium, H. S. Rawdon, Trans. Am. Electrochem. Soc., **49**; 1926; Metal Industry (London) **28**, p. 414; 1926; Korrosion und Metallschutz, **2**, p. 170; 1926.

LC 192, Corrosion resistance of iron and steel.

Bureau work on the effect of thickness of zinc coating on bend tests is included in tests on galvanized sheets, H. A. Stacy, for October, 1926, meeting, Am. Inst. Min. and Met. Eng.

Quality of Steel as Revealed by Carburization.—An investigation of the past several years has for its purpose the study of the influence of the initial quality of steel, the so-called "abnormal steel," upon the results obtained in the commercial process of carburization (casehardening). It has been definitely established that the depth of the carburized layer is greater and the surface hardness is more uniform in certain carburized steels than others carburized under identical conditions. Although some of the differences observed are attributable to different variables of heat treatment, such as methods of heating, rate of quenching and freedom of the quenching baths from dissolved gases, the character of the steel appears to be an important factor. One of the most outstanding features of "abnormal steel" is the relatively high aluminum content which accompanies abnormality in much commercial steel, although the presence of aluminum is not essential to abnormality. The investigation has been extended to include observations on the "finishing" of steel in the steel mill and is still in progress.

Testing for abnormality is required in the specifications of many users of steel for carburizing. A better understanding of the variables affecting abnormality and of methods for its control is desired by both makers and users of such steels. While there is no formal committee sponsoring this work, cooperation has been active, especially from automobile companies which are large users of carburizing steel and from several progressive steel mills. Close contact is also maintained with the Bureau of Mines, which is also concerned with the problem and actively studying it, because the causes of abnormality may include factors relating to the smelting of the ore itself as well as to the making and handling of the finished steel.

Publication.—Discussion, S. Epstein, Trans. Am. Soc. Steel Treat., **9**, p. 920; 1926.

Improvement of Duralumin.—Aluminum alloys of the "duralumin" type; that is, alloys which can be strengthened by heat treatment, such as are widely used in aircraft construction, not infrequently deteriorate very seriously in service, particularly if in sheet form. The deterioration, which manifests itself most plainly as an embrittlement of the material, is the result of a peculiar corrosive attack starting at the surface, wherein the "bond" between the constituent grains is weakened, although the grains as a whole are but little affected.

The prevention of deterioration is essential if reliable aircraft of long life is to be produced. Thin, bare commercial duralumin, such as would be used in the new "metal clad" airships, can be seriously embrittled in a week in the laboratory with distilled water as the only corrosion medium. Standard airships and airplanes depend upon duralumin for much of their structural strength and no substitute offers promise of as good a combination of strength and lightness.

The Bureau of Aeronautics of the Navy Department, the Army Air Service, and the National Advisory Committee for Aeronautics are, therefore, studying the problem by use of the bureau's equipment and staff. Manufacturers of the alloy and commercial users are also actively cooperating.

An investigation is under way for the study of the conditions which favor this type of corrosive attack and the means for guarding against it. To date, the results indicate that alloys containing considerable copper are most prone to deterioration of this kind, although the method of heat treatment used is an important factor. Chloride solutions, particularly under oxidizing conditions, produce corrosion of this type readily. The various kinds of protective coatings for use on such alloys are being investigated by means of laboratory corrosion and by out-of-doors exposure tests, the latter in cooperation with the Institute of Paint and Varnish Research.

Work of the past year has clearly shown that there is hope of decided improvement in the resistance of bare, unprotected duralumin to intercrystalline attack by control of composition and heat treatment, though it is doubtful if the problem is susceptible of a complete solution along these lines. But it is certain that proper attention to the protection of the surface by a suitable coating will solve the problem and no fear need be entertained in the use of duralumin so protected.

Good protection is afforded by various varnish or bitumastic enamel coatings properly maintained, by the "anodic" coating resulting from electrolytic treatment in chromic acid, as applied by English workers, or by the application of a thin coat of pure aluminum deposited by some of the metal spray processes. The choice among these will depend on the degree of protection needed, on the weight

36316—27——17

added by them and on the cost of application. While further information is needed to select the best coating, it is certain even at the present stage of the work that great improvement in reliability and life of duralumin parts of aircraft is assured.

Specifications for composition and recommended practice for heat-treatment and for the application of protective coatings may have to be modified as a result of the work, when the work is completed.

Publication.—Work dealing with the condition of the duralumin taken from the wreck of the *Shenandoah* is included in "Technical aspects of the loss of the U. S. S. *Shenandoah*," Jr. Am. Soc. Naval Eng., **38**, p. 605; 1926.

Etching Reagents for Alloy Steels.—The publication of S. 518, Metallographic Etching Reagents III, for Alloy Steels, by E. C. Groesbeck during the year marked the completion of this particular phase of metallographic investigation which has for its purpose the obtaining of data which will serve as a basis for "recommended metallographic practice." The use of alkaline etching reagents, under oxidizing and nonoxidizing conditions was found to be the most satisfactory means for the identification of the various "carbides" and other hard constituents occurring in the microstructure of commercial alloy steels. Electrolytic etching methods are also useful, whereas the commonly used acidic reagents will not give results that will serve to identify the different microconstituents.

Publication.—Solutions for carbides, etc., in alloy steels, E. C. Groesbeck appendix to report of committee E–4 on Metallography, Proc. A. S. T. M., **26**, pt. 1; 1926.

Phosphorus in Wrought Iron.—Specifications for wrought iron take account of phosphorus only through the effect it exerts on the physical properties as shown by the tensile and bend tests. A study of wrought iron made by both hand and mechanical puddling processes showed that marked variations, in phosphorus content occur in different parts of a bar of wrought iron. Tests taken at each end of a 12-foot bar showed a variation in impact value from 6.5 to 54 foot-pounds, due to segregation of phosphorus. In order that brittle segregated areas may be avoided the phosphorus content should be carefully controlled. The distribution of phosphorus may be of much more consequence than is the average phosphorus content.

Publication.—Observations on phosphorus in wrought iron made by different puddling processes, H. S. Rawdon and S. Epstein, Yearbook Am. Iron and Steel Inst.; 1926.

Properties of Silicon Steel.—A new German structural steel, low in carbon and high in silicon, was examined and found to have a good combination of properties, which, however, could also be obtained by the use of manganese, as is more common in American practice when steel of high yield point is desired, or by a combination of manganese and silicon. The work emphasizes the fact that more

attention might well be paid to the possibilities of the cheaper elements, such as silicon and manganese, as alloying agents in steel.

Publication.—"Silicon as an alloy in steel," H. W. Gillett, Iron Age, **118**, p. 481; 1926.

Properties of Steels at Elevated Temperatures.—The demands of engineers for alloys to withstand high temperatures and high pressures in such fields as oil cracking, nitrogen fixation, steam power plants, and so on, have brought out the fact that far too little is known about the properties of such alloys to allow drawing up specifications, and that methods of tests, either for inspection and acceptance test purposes or for research purposes are not yet sufficiently settled upon.

The American Society of Mechanical Engineers and the American Society for Testing Materials have, therefore, formed a joint committee on the properties of metals at high temperatures, upon which the bureau is represented. This committee is unique in that the metallurgists of firms in active commercial rivalry not only meet and discuss problems of joint technical interest, but apportion experimental work to each laboratory represented and share all the data thus secured. They realize that the problem is too complex for solution by any one laboratory and have accomplished a pooling of problems, of work, and of results, only too seldom found in industry.

Problems relating to methods of testing at high temperature have been referred to the bureau by the committee and the work of the bureau is oriented so as to supplement the work of the other laboratories represented on the committee.

Considerable work has been done to correlate results obtained from the so-called "short-time" tensile test at elevated temperatures with results obtained in "long-time" tests in which the material is subjected to a fixed load at approximately constant temperature.

Three steels have been so tested, a 0.24 per cent carbon steel, a high-speed steel, and a 20 per cent Cr., 1 per cent Cu "rustless" steel. A special steel of 23 per cent Ni., 18 per cent Cr. is now under test. "Long-time" tests, some of which have to go on for months, have been made at room temperature 550°, 800°, 1,100°, and 1,350°F., and "short-time" tests at the same temperatures.

Under a fixed total load in tension at approximately constant temperature, the total flow producing fracture takes place in three steps, the magnitude and importance of which vary with the applied load, temperature, and material. These three stages of flow are designated (1) an initial flow, (2) a secondary flow, and (3) a final flow. As the constant applied load is increased, the initial flow and the rate of flow in the second period increase and the life of the steels decreases. The final rapid flow is the result of stress concentration

brought about by decrease in cross section accompanying previous elongation.

Above the temperatures at which strain hardening is observed, the maximum allowable stress, which is taken as the load permitting long life with freedom from deformation, is equivalent to what has been called the "limiting creep stress" by other investigators and is approximated by the proportional limit of the "short-time" tension tests at corresponding temperatures. Within the temperature range in which strain hardening is observed, the proportional limit also approximates the load permitting long life with freedom from deformation, but is below the "limiting creep stress" which includes only consideration of long life.

A modified Martens extensometer equipped with the Tuckerman optical lever system was constructed for use in determining the proportional limits. The smallest direct reading obtainable with this instrument is equal to approximately four millionths of an inch, and permits detection of very small departures from the apparent proportionality between stress and strain, provided suitable loading equipment and temperature control are available.

A subproject of the main project is that of resistance to erosion by steam. A miniature steam turbine has been constructed and is being tried out for determining the resistance of different metals to steam erosion. The blades are made of different steels; boiler plate "rustless" steel, and other special steels and may be removed for observation and weighing at intervals.

Publications.—"Metals to resist corrosion at high temperatures," H. J. French, Trans. Am. Electrochem. Soc. **50**, 1926.

"Methods of test in relation to flow of steel at various temperatures," H. J. French, Proc. A. S. T. M., **26**, pt. 2, 1926.

Temperature Distribution in Quenching.—The heat-treatment of steel by quenching to harden the metal and reheating or tempering to soften it to just the desired degree, has been utilized empirically for centuries, as ancient heat-treated swords testify. The introduction of alloy steel multiplied the problems of the steel treater, and when he was called upon for quantity production of heat-treated parts, as in the automobile industry, it became necessary that heat treating approach an exact science. Seldom in industry is such exact control of temperature and other variables required as in heat treating.

With all the advances in the science, the theory of hardening by quenching and the exact mechanism of quenching are in considerable doubt. A detailed study of the mechanism of the quenching operation, both as regards the manner of cooling of the steel itself and the properties of the various quenching media has been undertaken.

By the use of special equipment it is possible to follow the temperature of the metal during the few seconds of quenching, and in this way the characteristics of quenching curves and the mass effect in quenching have been studied.

In order to understand the manner of cooling throughout the mass of a sample so that the depth of hardening and physical properties, in general, may be predicted when any size of the simple shapes is cooled from various temperatures in various media, it is necessary to have a knowledge of temperature distribution, which is the phase at present being studied.

The study of the surface cooling of these simple shapes in air is now being determined. There appears to be a hyperbolic relation between the cooling velocity at 720° C., and the diameter of sample cooled, similar to that obtained when cooling curves are taken at the center. There also seems to be a definite relation between the cooling velocity at 720° C. and the surface per unit of volume.

Publications.—Some Characteristics of Quenching Curves, by H. J. French and O. Z. Klopsch, T313; also Trans. Am. Soc. Steel Treat. **9**, p. 857; 1926.

Initial Temperature and Mass Effect in Quenching, H. J. French and O. Z. Klopsch, T295; also Trans. Am. Soc. Steel Treat, **9**, p. 33; 1926; also Fuels and Furnaces, **4**, p. 435; 1926.

Pure Zinc.—A study has been made of the physical properties and crystal structure of pure zinc. Proof was obtained that zinc has but one allotropic form between normal temperatures and the melting point. The following values were determined:

1. The average coefficient of linear expansion per degree Centigrade of pure cast zinc over the temperature range 20° to 100° C. is 0.0000395 (0.0000220 per ° F.) and over the temperature range 20° to 300° C. it is 0.0000393 (0.0000218 per ° F.).

2. The density of pure cast zinc is 7.131 g per cm^3 (0.2576 lbs./in.^{3}). There is no appreciable difference between the density of cast zinc as annealed or quenched from elevated temperatures up to 340° C.

3. The scleroscope hardness of pure cast zinc is not measurably affected by quenching the annealed material from elevated temperatures. The Brinell hardness of pure zinc decreases uniformly from approximately 31 at normal temperatures to 6.5 at 200° C.

4. The tensile strength of pure cast zinc is quite varible, but is probably about 4,000 lbs./in.^{2} at normal temperatures. There are indications of a slight increase in the tensile strength at slightly elevated temperatures followed by a marked and consistent decrease beginning approximately at 100° C.

5. Microscopic studies of etched strain-free surfaces of cast specimens annealed at temperatures up to 390° C. give no evidence of recrystallization of grain growth.

6. The value of the length of side of an elementary prism of the triangular close packed lattice of zinc (axial ratio 1.86) at normal temperatures is 2.65A.

7. The density of zinc computed from the X-ray data is 7.19 g/cm^3 (0.260 lbs./in.^{3}).

8. The crystal form at 250, 380, and 400° C. is the same as at normal temperatures.

9. The data obtained indicate that pure zinc has but one allotropic form.

Publication.—Pure Zinc at Normal and Elevated Temperatures, S522, by J. R. Freeman, jr., F. Sillers, jr., and P. F. Brandt.

Soldered Joints.—A brief study was made of the permanence of soldered joints under definite prolonged application of load. A 50-50 and 60-40 lead tin solder and pure tin were used.

It was found that pure tin is a stronger solder than either of the two alloys studied. Pure tin when used as a solder will apparently sustain indefinitely a unit shearing stress of 400 lbs./in.^{2} The lead-tin solders will sustain a unit shearing stress of 200 lbs./in.^{2}

Publication.—"Tensile properties of soldered joints under prolonged stress," J. R. Freeman, jr. and G. W. Quick, Metal Industry (N. Y.), **29**, p. 7; 1926.

Nonferrous Screen Wire Cloth.—This work was carried out by request of Committee D–14 on screen wire cloth of the A. S. T. M., as part of the general program of investigation to develop standard specifications for screen wire cloth, such as is used for window screens and screen doors. Accelerated corrosion tests were made on wire cloth of seven different nonferrous alloys. The results of these tests will be compared with results of actual exposure tests now in progress.

The material was mounted in metal and wooden frames under customary manufacturing conditions. Screens representative of each of the seven kinds of cloth from different manufacturers in both types of frames have been set out for atmospheric exposure in four different locations.

Publication.—"Laboratory tests on nonferrous screen-wire cloth," G. W. Quick, Appendix to report, Committee D–14, Proc. A. S. T. M., **26**, pt. 1; 1926.

Sound Ingots and Rails.—The causes for some types of failure of railway rails in service are obscure, neither the purchase specifications and inspection tests of the railroads nor the precautions now taken in rail manufacture by the steel mills being sufficient to prevent failures. The International Railway Congress at its 1925 meeting adopted a resolution recommending that provision be made against segregation by suitable requirements laid down in the specifications for rails. Segregation was stated to be the probable primary cause of most rail failures, and a suggested method for avoiding segregation was the use of ingots cast big end up and with an adequate sink head.

Data on the properties of rails made from such ingots in comparison with those made in the ordinary manner will be helpful when the suggestion of the congress as to altering specifications is to be considered.

With the cooperation of the Gathmann Engineering Co. a comparative study of the segregation and the properties of rails made in both ways is in progress. Other phases of the problem are being studied in cooperation with the American Railway Engineering Association.

Vacuum Fusion Method for Oxygen and Hydrogen in Metals.—Many obscure phenomena in the behavior of metals and alloys are often ascribed to the presence of gases. Proof of the relationship of gas content to good or bad performance of metals requires a knowledge of the amount and kind of gases present. While part of the gaseous elements are present as compounds and part may be present in other conditions, the foundation for a consideration of the problem requires accurate methods for the determination of the total amount present. Such small amounts of these elements are present that very specialized procedure is required for precision work.

A new vacuum fusion method for determining oxygen and hydrogen in metals has been in process of development in the bureau's laboratories for several years. In this method the metal sample is melted by high-frequency induction under a vacuum in a gas-free graphite crucible and the oxygen and hydrogen content of the sample determined by absorbing and weighing the carbon dioxide, carbon monoxide, water vapor, and free hydrogen in the gases evolved from the molten specimen. The method permits the determination of total oxygen in many metals not before possible, and is already in use in several commercial research laboratories.

Other methods for determination of gases in metals are being examined, one for oxygen in which the specimen is fused with an alloy of antimony and tin, in cooperation with a research fellow of the Swedish Engineers Academy, and several methods for determination of nitrogen.

These methods have found use in research work and it is probable that when sufficient research has been done fully to establish the correlation between gas content and the properties of metals, specifications for metals will in some cases include gas content.

In cooperation with the University of Michigan the vacuum fusion method for oxygen was applied to specimens of coke and charcoal iron. The results did not bear out some of the theories that have been advanced as to the effect of oxygen.

Still another phase of the work on gases in metals was the study of the effect of hydrogen on iron and its bearing on a new transfor-

mation which an Italian investigator had claimed to exist, but which was not found when his work was repeated at the bureau. The phenomena reported by him may, perhaps, be due to hydrogen, but is not inherent in the iron itself.

Publications.—Gases in Metals II. Determination of Oxygen and Hydrogen by Fusion in Vacuo, L. Jordan and J. R. Eckman, S514.

"Determination of oxygen and hydrogen in metals by vacuum fusion," L. Jordan and J. R. Eckman, Ind. Eng. Chem., **18**, p. 279; 1926; Metal Ind. (London), **28**, p. 387; 1926.

"Oxygen affects charcoal iron," J. R. Eckman, L. Jordan, and W. E. Jominy, Foundry, **54**, p. 506; 1926.

"Some effects of hydrogen on iron and their bearing on a reported transformation at 370° C.," H. S. Rawdon, P. Hidnert, and W. A. Tucker, Trans. Am. Soc. for Steel Treating, **10**, p. 233; 1926.

Physical Constants of Pure Metals.—The physical constants of pure metals are obviously of fundamental importance both from a purely scientific and from an engineering viewpoint. Each notable advance in the purity of the more common and widely used metals, as well as any success in the preparation of the rarer metals in a pure state, requires new determination of physical properties. The bureau at present has in progress such work on pure iron prepared in its own laboratory, on pure nickel prepared by cooperation of the International Nickel Co. with the bureau, and on pure thorium prepared by the Westinghouse Lamp Co. Work has previously been done upon pure platinum, and this is being extended to other metals of the platinum group.

In all this work the melting of very pure metals without contamination by the refractory crucible or container is a task requiring refractories of special properties. As a by-product of the study of such refractories it was possible to develop a lining of electrically sintered magnesite bonded with the same material hydrated by grinding with water in a ball mill for use in the bureau's experimental electric steel furnace, which has given very satisfactory service.

Publication.—"Refractories for melting pure metals—iron, nickel, platinum," L. Jordan, A. A. Peterson, and L. H. Phelps, Trans., Am. Electrochem. Soc., **50**, 1926.

Methods for Testing Molding Sands.—The quality of sand castings depends not only upon the metal poured into the molds, but also upon the quality and suitability of the molding sand.

In recent years the American Foundrymen's Association has recognized this, and through its joint committee on molding sand research has been perfecting and simplifying methods for testing sand and for control of sand in the foundry. A large number of foundries and of consulting laboratories have taken up sand testing, and it has been shown of much value in avoiding defective castings.

While no general specifications for molding sand have yet resulted, sand testing has made possible the intelligent use of the sands, found in various localities and the substitution of one sand for another.

The bureau has taken an active part in the whole work of the joint committee and has done much experimental work upon appliances for the methods of testing. This work has been reported to the committee and has been published as part of the committee reports. Recent work for the committee has dealt with the spring type of compression testing apparatus, with a simplified type of permeability tester and with a simplified method for determining clay in sand.

Besides the work for the committee a study is in progress upon a method for determining the sintering point of molding sand, and considerable work has been done in cooperation with the Washington Navy Yard, both on the installation of methods of control of molding sand and on the examination of local sources of supply. The yard hopes in time to be able to set up specifications for sands. The bureau has also done considerable work in testing sands for The Panama Canal.

Publication.—Work included in report of subcommittee on tests, joint committee on molding sand research, Am. Foundrymen's Assn. meeting; September, 1926.

CLAY AND SILICATE PRODUCTS

Investigation of Feldspar and Its Effect in Pottery Bodies.—For the past two years an investigation of commercial feldspars has been conducted by the Bureau of Standards in cooperation with the whiteware division of the American Ceramic Society. The primary object of this investigation is to obtain the necessary data to make possible a better understanding of the inherent physical and chemical properties of individual representative feldspars in order that they may be used more intelligently by the manufacturer and also that he may be able ultimately to purchase materials of desired characteristics on specification.

The program of the investigation comprises the determination of the properties of 19 representative commercial feldspars and of their effects on the firing behavior of typical vitreous and semivitreous white ware bodies in which they are used. During the past year the greater part of the outlined program has been carried out, and in February a progress report was presented at the annual meeting of the American Ceramic Society. The following properties of the feldspars have been determined: Softening point, chemical composition, specific gravity, fineness, and deformation range. In attempting to grade the feldspars according to the tentative specifications it is found that, as regards alkali content, 10 of the 19 feldspars do not qualify for any grade and, as regards fineness, three do not qualify. Also, the

difference between the results of fineness tests made by the different laboratories is greater in some cases than the differences limiting the grades.

A progress report has been published in The Ceramist, Vol. 6, No. 6, September, 1925, p. 708.

This extensive investigation of the physical and chemical properties of commercial feldspars afforded an opportunity to develop and test microscopic methods for their quantitative analysis. The ceramic and allied industries have long felt the need of a rapid analytical method which could be used in the control of feldspar purchased by them and such a method should be applicable to the checking of the composition of carload lots of the material as received.

A quantitative method making use of the polarizing microscope was felt to be practicable since tests of a feldspar by this instrument would give results in terms of its mineral constituents and could be directly correlated with variations in the physical properties. Nineteen commercial brands of feldspars which have been analyzed chemically were available for experimentation. The method which finally proved most satisfactory was one by which the grains of the different constituents were distinguished on the basis of their indexes of refraction and the amounts present were estimated by counting the grains of each constituent in several random fields of a specimen as prepared for microscopic examination. The analyses thus made were compared with chemical analyses, which had been computed in terms of mineral constituents, and were found to give results which were in fair agreement. This investigation has been completed and a report is being prepared for publication.

The Resistance of Ceramic Glazes to Abrasion.—The practical problem which led to this investigation is the limited usefulness of white wares due to the unsightliness of the glaze which becomes scratched, abraded, and otherwise disfigured, while the ware is still mechanically serviceable.

The principal features of the investigation were: (*a*) The development of a suitable method of determining glaze hardness; (*b*) the determination and comparison of the hardness of commercial brands of chinaware; and (*c*) the study of the effect on glaze hardness of variations in composition, thickness, firing temperature, and body used.

The method developed for determining hardness consists of: (*a*) Abrading the test specimens with standard Ottawa silica sand which falls through a definite orifice and from a fixed height onto the glazed surface which is set at a predetermined angle to the vertical, and (*b*) measuring the abrasive effect of the sand with an Ingersoll glarimeter.

A typical white-ware glaze was prepared and its silica and alumina content varied uniformly and independently to determine the effect on hardness. This study showed that, for a given body and firing temperature, the maximum hardness for any glaze is obtainable only when its chemical composition is adjusted carefully and within comparatively narrow limits.

Glaze thickness had an appreciable effect on the hardness of the experimental glazes, which was determined from specimens varying in thickness only. Each glaze reached its maximum hardness at a definite thickness dependent upon the type (other conditions being constant), thus illustrating the necessity for controlling this factor

Increasing the firing temperature hardened the experimental glazes, the more refractory ones being affected more than the less refractory ones for equal increases in temperature.

Both vitreous and semivitreous bodies were used. The experimental glazes were not appreciably affected by the type of body used upon firing to cone 7, but as the temperature was increased they became harder on the vitreous than on the semivitreous bodies.

A Study of the Composition and Physical Properties of Specia Glasses.—This investigation is being carried on with the assistance of the Navy Department. Its purpose is to determine the conditions which affect the quality of optical glass during melting, molding, and annealing. During the course of the work a considerable quantity of optical glass of excellent quality and of various kinds is made, and most of it is used by the Navy Department for replacement and in constructing new optical instruments. During the past year approximately 15,000 lens blanks weighing 1,800 pounds were made for these purposes. Small amounts of the glass are used by this bureau for special scientific apparatus.

The Measurement of the Viscosity of Glass.—Information in regard to the temperature-viscosity relations of glasses of different composition is of great interest to the glass manufacturer because it is thought that such data will determine the most advantageous temperatures for melting, fining, and working glasses.

The apparatus, which is a rotary type viscosimeter, was calibrated with a mineral oil of naphthene base between 200 and 25,000 poises. The viscosity of this oil at any given temperature was found from an empirical equation based on experimental data obtained with a capillary flow viscosimeter. A large number of determinations were made with the rotary viscosimeter using weights varying from 5 to 25 grams at each temperature.

Attention was then turned toward the determination of the viscosity of three kinds of optical glass. It was found that in the case of the more fluid light barium crown and borosilicate glasses, the solution of the clay stirring rod would suffice to increase th e viscosity

by 30 or 40 per cent unless proper precautions were taken. Fairly accurate data could be obtained by working rapidly at the higher temperatures, although above 1,100° C. corrosion was very difficult to avoid. The corrosive effect of soda-lime glass was not very pronounced, however, the viscosities of three commerical glasses were also determined.

In order to provide fundamental data from which it is thought the viscosity of a glass of any composition can be calculated, the viscosities of a large number of glasses will be determined, beginning with the simplest glasses (soda-silica) and then modifying these by adding, singly and in various combinations, the other glass-forming oxides, such as alumina, lime, magnesia, potash, and the oxides of lead, zinc, boron, and barium. Up to the present time considerable difficulty has been experienced in making these special glasses of satisfactory quality for this work, but persistent effort will probably remove this difficulty.

Microscopic Examination of Boiler Furnace Refractories.—As a part of an investigation of the properties of refractory brick used for boiler furnaces, microscopic examination was made of six types of brick which had been used in such an installation. It was hoped that the microscope would show the differences in the composition and structure of the brick as well as the factors affecting the depth of penetration of slag into the brick. The bricks varied in composition from those having a large excess of silica (present as quartz, tridymite, and cristobalite) to those showing an excess of alumina (present as corundum). Mullite ($3Al_2O_3.2SiO_2$) was a constituent of all the bricks examined. The results of this microscopic examination have been incorporated in a paper on "Boiler furnace refractories," by E. B. Powell, of Stone & Webster.

Problems Relating to Sagger Clays.—The first of the two phases, into which this problem has been divided, is being confined to a study of the characteristics of 51 individual representative clays. The first "Progress report on the investigation of sagger clays," by R. A. Heindle, appeared in the March, 1926, issue of the Journal of the American Ceramic Society, vol. 9, No. 3, page 131. A "Second progress report," by R. P. Gelter and R. A. Heindle, covering the thermal expansions and their relation to results of laboratory quenching tests has been published in the September, 1926, Journal of the American Ceramic Society, vol. 9, No. 9. A description of the apparatus used for these observations is given, and the results may be summarized as follows:

(*a*) The inversions of uncombined silica were sharply defined in some cases and barely discernible in others.

(*b*) There appear to be two distinct types of clays as regards thermal expansion and resistance to sudden temperature change.

One group of clays expand very rapidly between 100 and 200° C. and saggers made from these clays crack below 500° C. in an air quenching test. The second group includes clays of average expansion between 100 and 200° C., and fail in the air quenching test at temperatures above 500° C.

(*c*) It was shown that repeated burns tend to decrease the expansion between 500 and 600° C. and increase the expansion between 100 and 200° C., indicating a resultant decreased resistance to sudden temperature change.

(*d*) Supplementary tests of clay-corundum mixtures clearly showed that artificial corundum, while increasing the total average expansion of the clays with which it was used, tends to eliminate irregular expansion due to inversions of uncombined silica.

Although the observation of linear thermal expansion of these clays gave valuable data bearing on the life of the saggers, it appears advisable to augment this information with an additional study of the characteristics of typical individual clays. For this purpose an apparatus has been designed and constructed with which it is planned to determine the following properties at elevated temperatures: The elastic limit, the modulus of elasticity in shear, deformation in shear, and transverse strength. The correlation of these data with those already collected should complete the first phase of this investigation.

Study of Tank Block.—Tank block are used in the construction of the bottom and sides of tanks in which glass is melted for the production of all types of glass hollow ware. When tanks first replaced pots for melting of glass, an average life of from 20 to 24 months was not unusual. Since this time the speed of production has advanced so that considerably more glass is melted, not only for the same melting area but also at higher temperatures. This has resulted in the lowering of the average life of tanks to from 10 to 12 months and made it desirable to undertake a study of the factors controlling the life of tank block. This has involved the study of not only the physical and chemical characteristics of various commercial and special block but also a chemical and petrographic study of the compounds formed by the reaction of the glass and the clay block. The data obtained to date appear to justify the following general conclusions:

1. Corundum and mullite, under the physical conditions existing at the contact of tank block and molten glass and with the concentration obtaining, resist solution better than other possible solid phases and, therefore, refractories made of these materials should show the greatest resistance to glass attack.

2. The physical structure of the clay block is the predominating factor controlling its life in service irrespective of chemical composition. The block should be homogeneous, the pores should be

small and, if possible, closed or noninterconnecting, and this structure should be obtained with a minimum of interstitial glass.

3. The solution of submerged portions of the block is due primarily to accelerated attack of the glass on the upper surfaces of pores, cracks, and laminations rather than to erosion brought about by movements in the main body of the glass.

4. The use of very high temperatures (1,450° C. and higher) can be expected to materially shorten the life of tank block, due to the decreased viscosity of the glass and the increased solubility of the tank block constituents.

Cast Iron for Enameling Purposes.—This investigation was undertaken in cooperation with the metallurgical division of the Bureau of Standards and with the American Ceramic Society in an attempt to determine the possible differences between northern and southern pig irons which might be the cause of blistering of the enamels when applied to castings made of northern iron. Some of the ideas as to the causes and elimination of blistering advanced by enamelers have not been found to hold when tested experimentally in a systematic fashion. Representatives of the American Ceramic Society have cooperated in working out methods for control of the enameling procedure so that some causes of erratic results due to the enamel rather than the iron, have been eliminated.

Metallographic examination of blistered and unblistered irons reveals no sure difference. While much more work will be required to establish the causes of blistering at the present stage it appears that the problem is more likely to be solved by control of foundry practice rather than by changing the specifications for the iron.

Since the results of enameling seem to indicate that castings of any iron that are either spongy or pinholed blister during enameling, while those which are not defective enamel well. These results lead to a new line of thought, that of fluidity of the cast iron while it is being poured into the molds. The work will be continued by enameling specimens of various irons melted in the cupola and in the electric furnace, using the standard enameling procedure.

Physicochemical Factors Affecting the Properties of Enamel Suspensions.—One of the problems which has received considerable attention from enamel manufacturers during the past few years is that of obtaining proper methods of controlling the consistency of enamel slips. This bureau has undertaken a study of the fundamental factors affecting the consistency of enamels in order to obtain definite methods for commercial control. The following conclusions have been drawn from the work thus far completed:

1. No change in hydrogen ion concentration necessarily accompanies change in consistency of enamel slips.

2. A reagent which brings about deflocculation of the finer particles of frit and clay reduces the yield value of the slip and facilitates settling of the coarser particles, while one which causes a flocculation of the finer particles increases the yield value and retards settling of the coarser particles.

3. Increasing fineness of grinding of a ground coat increases the yield value and decreases mobility.

4. Aging a slip lowers its yield value.

5. Artificial increase of the concentration of materials dissolved from the frit produced a decrease in yield value as great as that caused by aging, indicating that the cause of the change with aging was solution of the frit.

6. Adding the usual amount of borax to a ground coat nearer the beginning of the grinding process retards grinding and causes a lower yield value of the slip.

Physical Properties of Clay Bodies as Affected by Drying Treatment.—The object of this investigation is the securing of such data on the drying behavior of clays and shales as will be of use in standardizing and operating commercial drying equipment for the most efficient and satisfactory drying of clays. At the request of the Heavy Clay Products Institute the year's work has been confined chiefly to those clays used by the Bureau of Mines in their work on the Burning Problems of Industrial Kilns, 1921–22.

The following conclusions seem justified from the data which have been obtained to date:

1. Drying of briquettes 1 by 1 by 7 inches gives no indication of the behavior to be expected of full-sized brick or tile.

2. Successful drying has been found to depend on preserving a fairly low shrinkage gradient within the drying clay body.

3. For a good drying clay the shrinkage water should not constitute over 50 per cent of the water of plasticity, and the shrinkage should be practically complete at 85° C.

4. Successful drying requires a high relative humidity and a temperature not over 45° C. for the first one-fourth to one-third of the total drying period.

Problems Relating to the Design of Hollow Tile and Brick Extrusion Machines.—As a result of a conference of Government and industrial representatives in the fall of 1923, a study of the design factors of augers and dies for extrusion machines was undertaken. The investigation as proposed by the Bureau of Standards embodies a study of the fundamental principles of auger and die design governing efficiency in the manufacture of brick and hollow ware.

It was found that a very slight decrease (2¼ per cent) in the moisture content after the point of optimum plasticity had been reached caused a decrease of more than 50 per cent in the work-

ability. The enormous increase in pressure to produce flow, compared with the slight decrease in water content, illustrates the extreme fluctuations in power requirement in the operation of auger machines.

In addition to the laboratory tests, all available literature and Patent Office records dealing with the development of auger machines during the past 60 years have been reviewed and correlated for future reference.

Investigations and Recommendations for Stucco Construction.—During the past 15 years the Bureau of Standards in cooperation with interested manufacturers and associations has been carrying out a series of investigations for the improvement of stucco construction. The results of all these investigations have been summarized and a recommended specification for Portland cement stucco construction has been prepared and will be issued during the year as a bureau circular under the title "Stucco Investigations at the Bureau of Standards with Recommendations for Portland Cement Stucco Construction."

Stevenson Creek, Calif., Experimental Concrete Arch Dam.—The Bureau of Standards is cooperating with the arch dam research committee of the Engineering Foundation in obtaining the test data on the experimental arch dam constructed on Stevenson Creek, Fresno County, Calif. There are practically no physical data as to the action of the arch dams in existence which accounts for much of the confusion on the subject of arch design. Lack of proper information upon which to base such designs is a serious impediment to this important type of construction and in many dam locations the use of the arch in place of the heavier gravity types offers the possibility of combining marked economy with greater safety. The experimental dam has been tested in order to obtain exact information under working conditions concerning the stresses, movements, and changes of volume of thin arch dams so that design procedure may be brought into accord with conditions as found on a full-sized structure. The data obtained are being studied and prepared for publication.

Proportioning and Grading of Aggregates for Concrete Strengths.—With the increased cost of labor and materials it becomes more and more important to obtain given design strengths for concrete by proper proportioning and grading of the constituent materials. The Bureau of Standards is carrying out an extensive study of the effects of different cements, different types of aggregates, proportions of materials, gradation of coarse aggregates, and the ratio of fine to coarse aggregate on the strength of concrete at several ages.

Hollow Tile and Concrete Floor Slabs.—An investigation of the structural value of hollow tile when combined in slabs of hollow

tile and reinforced concrete has been recently completed at the Bureau of Standards. The results of this work will be found in T291, Tests of Hollow Tile and Concrete Slabs Reinforced in One Direction, by Douglas E. Parsons and Ambrose H. Stang.

Shear Tests of Reinforced Concrete Beams.—During the World War the great demand for ships led to the construction of reinforced concrete ships. The use of concrete for such a purpose necessitated a new set of standards for design. Under the usual working stresses it was found necessary to make the wall from 12 to 15 inches thick. A series of tests were started to find a means of reducing the thickness, and the results showed that by the use of sufficient steel reinforcement properly placed in the walls of the ship it was safe to make the shell only 4 or 5 inches thick instead of 12 or 15.

The prospect that the information would be of great value in the construction of bridges and buildings as well as in ship work led to the extension of the tests to include many additional phases of the problem. This work has been completed and the bureau has now prepared the results as T314, entitled "Shear Tests of Reinforced Concrete Beams," by W. A. Slater, A. R. Lord, and R. R. Zipprodt.

Durability of Concrete in Alkali Soils.—Members of the bureau staff completed an inspection of the Western alkali field installation in the fall of 1923. A detailed description of the work and the conditions found at each site has been prepared. Further, the work previously accomplished has been summarized and while the conclusions already drawn up and presented in other papers by the bureau are not materially changed, a full report has been published as it gives the results for a full 10-year exposure period for many of the installations. This paper was released during the year as T307, entitled "Durability of Cement Drain Tile and Concrete in Alkali Soils; Fourth Progress Report," by G. M. Williams and Irving Furlong.

Concrete Products.—During the year considerable study has been made of the properties of concrete units. A circular has been prepared dealing with the essential factors concerning the manufacture and properties of concrete building units. This has been released as C304, entitled "Properties and Manufacture of Concrete Building Units."

Physical Properties of the Commercial Limestones.—Due to frequent calls for information on the properties of limestones now on the market a testing program has been undertaken by the bureau to supply the desired data. Samples have been collected as far as possible from all the important producing districts and the tests have been completed. The results of the work which include data on the compressive strength, transverse strength, shearing strength, elasticity, absorption, porosity, and unit weight are being prepared as a

Technologic Paper under the title "Physical Properties of the Principal Commercial Limestones Used for Building Construction in the United States," by D. W. Kessler and W. H. Sligh.

Cleaning Stone Work.—In connection with the limestone research fellowship at the Bureau of Standards considerable time has been given to the study of cleaning masonry by means of the steam jet. Actual field cleanings have been carried out, and encouraging results have been obtained. Due to its economical features and freedom from injury to the stone it seems that this process should be more generally employed. An article dealing with some of the results obtained by this method appears in the June 20, 1926, issue of the American Architect.

Installation and Care of Interior Marbles.—The bureau is cooperating with the National Association of Marble Dealers in a study of several problems in the installation and care of interior marbles. The problems are the development of protective treatments against discoloration, methods of removing deep-seated stains due to various causes, determining the effect on marble and the relative merit of the several cleaning compounds, and the development of proper methods for cleaning marble.

Considerable work has been accomplished on the removal of stains and methods of cleaning and a series of articles by D. W. Kessler have appeared during the year in the marble dealers' trade journal Through the Ages, of February, March, April, June, July, and September.

Colorless Waterproofing Materials.—Exposure tests, on specimens of sandstone and limestone treated with various types of colorless waterproofing materials, are being conducted to determine the durability of the treatments. The waterproofing treatments under test include all the common types in general use. The tests involve a long exposure to the weather of treated samples of stone which are submitted to absorption measurements at intervals. Some of these tests have been in progress for six years, which indicate that the paraffin treatments are the most durable and that this type of treatment does not deteriorate appreciably during this period. These tests are the continuation of the work described in T248, by D. W. Kessler, entitled "Exposure Tests on Colorless Waterproofing Materials," which paper was based on the results of exposure tests at the end of two years.

Constitution and Hardening of Cement.—In addition to the studies of cement carried on in cooperation with the Portland Cement Association, work has been done in the study of cements composed largely of oxides of titanium or barium. It was found that the former developed no particular hardening properties unless considerable amounts of alumina were present. The study of barium silicates and

aluminates showed that both, and especially the latter, develop excellent hardening properties. However, neither was hydraulic, since the large amount of barium hydroxide which crystallized from the silicate ultimately resulted in disintegration and the large amount of a reversible very sticky colloid formed from the aluminate in the presence of water resulted in expansion to such a degree that failure resulted when the hardened aluminate was placed in water. Some cements approaching the composition of Portland cement, but containing varying amounts of iron, were also made, but the data obtained did not permit of making any positive conclusions.

Many of the quick-hardening Portland cements now on the market were tested and found to possess this quality in varying degrees. None showed any marked difference in composition from that of ordinary Portland cement. Generally, they are much finer ground, and while they show excellent strength in concrete at 72 hours none approach the strength in concrete of the high aluminate cements at 24 hours.

Considerable time was spent in studying the heat of reaction of Portland cement in an adiabatic calorimeter. The automatic control for the calorimeter has not yet been worked out, and this is essential as heat is evolved over a long period—60 hours or more. However, the apparatus shows that different Portland cements have different rates of reaction during the first eight hours and that the gypsum added to regulate the set retards the rate during this period.

The complexity of the problem dealing with the hardening of cement has not permitted of much advance in this study. The work was restricted largely to the aluminates, and while it was found that the hydrated tricalcium aluminate is one of the products of hydration there is also evidence that there is a tetracalcium aluminate and possibly also an aluminate of a low lime-alumina ratio. The reaction of the aluminates with water containing chlorides and sulphates was also studied and one calcium chlor-aluminate and two, or possibly more, calcium sulpho-aluminates were noted.

Use of Lime in Chemical Industries.—During the year one recommended specification for lime, namely, for use in the purification of water, prepared by the Interdepartmental Conference on Chemical Lime, has been issued as C231. Several other specifications have been prepared by the conference, which include those for lime for use in tanning of leather, the manufacture of soap, and the distillation of ammonia. However, before publication of the latter two the bureau has been requested to conduct some investigative work to determine the insoluble matter in 1:9 hydrochloric acid in hydrated lime and the fineness of slaked chemical quicklime. For these purposes representative samples of chemical hydrated lime and chemical quicklime have been obtained from the manufacturers.

Bond Between Mortar and Sand-Lime Brick.—An investigation to determine the strength of the bond between mortar and sand-lime brick is now being conducted by the bureau. One phase of the problem necessarily consists of a study of the effect of various physical properties of the brick, such as total absorption, density (including pores), specific gravity of solids in the brick, and rate of drying, upon the adhesion of the mortar to the brick. Consequently these properties have been determined upon 1,325 individual bricks, representing the product of eight manufacturers. Some very interesting relationships have been found to exist, including the following:

When sand-lime brick are immersed in water, those of the highest total absorption show the most rapid rate of absorbing water at the start, and they are the first to approach a condition of saturation; the limit of their capacity for absorbing water is nearly reached in 12 hours, and very little more water is absorbed if the immersion is continued for seven days. At the end of seven days' immersion sand-lime bricks contain on the average 4 per cent less water than when boiled for five hours. The rates of absorbing water sometimes vary more between bricks of one make than between the average rates of bricks of two makes. The specific gravity of the solids in sand-lime brick is so nearly the same that one can locate a smooth curve by plotting the points which represent the total absorption and the density (including pores) of a number of bricks. Such a curve can be used in determining the total absorption of other sand-lime bricks without the use of water merely by determining the density of each. Bricks which are more porous dry out a little faster than those less porous and retain less water when air dry, which amount varies from 0.5 to 1.0 per cent or more of water, depending upon the material of the brick and the relative humidity.

The data obtained were made the basis of a paper entitled "Some physical properties of sand-lime brick," by H. V. Johnson, which was presented at the twenty-second annual convention of the Sand-Lime Brick Association and published in the 1926 proceedings.

Some Properties of Gypsum-Lime Mixes.—During the year the properties of gypsum-lime mixes, such as used in the finish coat in plastering, with reference to time of set, tensile and compressive strength, shrinkage and plasticity, have been determined, in which the composition was varied by 5 per cent increments from 100 per cent lime to 100 per cent calcined gypsum. The results obtained indicate the following:

1. Quicklime and hydrated lime, when added in small amounts to calcined gypsum, accelerate the time of set. Maximum acceleration occurs when approximately 10 per cent by weight of hydrated lime is present. When more than 50 per cent hydrated lime is present

retardation occurs, which becomes marked at about 70 per cent, when the time of set approaches that of pure lime.

2. Hydrated lime in small amounts increases the tensile strength of calcined gypsum. A calcined gypsum-hydrated lime mix, rich in hydrate (in excess of 85 per cent), has a greater tensile strength than a mix of like composition containing an equivalent amount of quicklime.

3. The addition of lime to calcined gypsum in all amounts lowers the compressive strength. The compressive strength of a gypsum-hydrate mix is greater than that of a gypsum-quicklime mix, where the lime content is equivalent.

4. A certain amount of lime may be added to calcined gypsum without affecting the shrinkage on setting, but above this definite amount the addition of lime increases shrinkage.

5. Lime in all proportions increases the plasticity of calcined gypsum.

Weatherproofing of Gypsum.—In attacking the problem of weatherproofing gypsum for outdoor uses three general methods presented themselves: First, covering the set material with some waterproof coating in order to keep the moisture from the gypsum. Second, precipitating on the surface an insoluble compound formed by a reaction of some material with the gypsum; and third, by the addition of an integral waterproofing compound to the gypsum, which when the gypsum has set acts as a water repellent. Among the more recent compounds used which indicate the possibility of being successful as a weatherproofing material, blood albumin is by far the most promising. Cylinders of neat gypsum, to which a small amount of blood albumin glue was added to the mixing water, are resisting the weather unusually well. The cylinders that were treated with barium hydroxide are also weathering satisfactorily.

Rate of Drying of Wall Plaster.—It is the general opinion that in the decoration of plasters the plaster should be dry, or almost so, for a satisfactory job. The question then arises as to when is a plaster dry. It is considered to be dry under the existing conditions when the humidity of the air in the pores of the plaster is the same as the humidity of the air surrounding the plaster.

To date the rate of drying of gypsum, lime, and cement plasters of the usual compositions in both sand-float and white-coat finishes with one-half inch and seven-eighths inch grounds, has been determined at a temperature of 98° F., exposed to both dry and humid air at a velocity of 80 cubic inches per minute. The results of these tests indicate that of the three plasters, lime dries the slowest and gypsum the fastest, with cement intermediate, when the conditions are the same. However, the difference in time necessary for the drying of gypsum and cement plasters is almost negligible. With

seven-eighths inch grounds the difference in time necessary for drying in the case of the slowest and the fastest is only about 30 hours. The results also show that the time necessary for drying in the case of all of the plasters increases with the humidity. While four days were required for gypsum plaster of seven-eighths inch grounds to become sufficiently dry to be satisfactorily decorated when exposed to dry air, five days were required for the same plaster when exposed to humid air. The other plasters showed a corresponding increase in the time necessary for dryness when exposed to humid air.

Determinations have also been made of the rate of drying of the same type plasters at 86° F., employing humid air at a velocity of 80 cubic inches per minute. Measurements are now being made at the same temperature exposed to dry air with the aforementioned velocity.

Determinations were made during the past winter of the rate of drying of the same type plasters at 72° F., using humid air at a velocity of 80 cubic inches per minute. Under these conditions the rate of drying of plasters is very slow indeed, some requiring six weeks to dry completely. Next winter the same type plasters will be dried at the same temperature and air velocity, but exposed to dry air.

Bibliography on Gypsum.—Although much has been written about the occurrence, composition, manufacture, technology, and uses of gypsum, the information has been so scattered that to obtain any data at all from the literature required much time and trouble. A bibliography on the subject was found to be almost imperative. Therefore work was started to compile a card index of all the subjects published on gypsum and several thousand articles have been listed and the bibliography will be completed this year.

SIMPLIFIED PRACTICE

Simplified practice means the reduction of industrial waste through the elimination of unnecessary diversity in sizes, types, dimensions, etc., of manufactured products. The advantages to be gained through the adoption of simplification are: Decreased production costs, selling expenses, misunderstandings, and costs to user. At the same time, it quickens turnover, permits shipment from stock, and tends to give the consumer better value for his money. Simplified practice does not usually lend itself to the style field or individual creation.

Standardization, involving quality, composition, performance, methods, dimensions, or types, is based on research before all of the varying factors are evaluated and brought to bear upon the ideals represented by such standards. Such research necessarily involves a

considerable period of time devoted to the technical and scientific aspects of the problem. And to this research simplified practice offers a short cut in many instances by its concentration on the active items based on sales in any line of products. This permits the standardization effort to likewise give greater attention to the needs as indicated by the trend disclosed in the simplified practice development.

To the uninitiated there comes a question as to how a simplified practice program meets the changing trends of demand due to invention, the improvement of scientific methods, and other forms of progress.

In any conference of producers, distributers, consumers, and others called by the division of simplified practice, there are two actions which a conference is asked to take in addition to the adoption of such simplified practice recommendations as it feels are of greatest benefit. The first of these is to make the recommendations effective for a definite period, generally a year, and from a definite date. The effective date is made long enough after a program has been adopted to enable all groups to prepare for the change, to broadcast the notice of the change to the public at large, and to clear away stocks of the eliminated varieties. The second is to provide for means of making revisions at the end of the period when the recommendations are in effect. This may be done either by another general conference of all the groups, or it may be accomplished through a standing committee of the industry, such a committee including representatives of manufacturers, wholesalers, retailers, consuming groups, and technical or scientific organizations.

The latter is the more common plan. To the standing committee there are referred all matters dealing with adherence to the program, suggestions as to needs for reinstatement of eliminated items or the elimination of further items, information as to new developments either in methods, invention, or of other factors which would effect the program in any way. Periodical meetings of the standing committee and surveys conducted by the committee afford the means of developing revisions to be submitted to the industry when a continuation of a simplified-practice program is up for consideration.

In the make-up of such standing committees lies a further opportunity for the trade association to serve its membership as well as the industrial or commercial community by inducing the widest adherence to the program, and an intelligent study of needed changes or revisions.

One great contribution made by the trade associations to this coordination of the waste elimination movement has been the disclosure of conditions showing the need for simplification and standardization. Notable instances of this include surveys made by the

National Retail Hardware Association and the National Supply and Machinery Distributers Association. These have brought to light a surprising variety, and have indicated many opportunities for simplification.

It is also noteworthy that the trade associations of distributers and consuming groups have been equally active in their acceptance of, and support of the simplified-practice programs in various fields. More than 400 such organizations which have accepted such recommedations include some 60 producer, 90 distributer, and 250 consumer trade associations.

One influence of the simplification movement has been to lead to the formation of trade associations in a few industries where simplified practice has been undertaken. The Concrete Steel Reinforcing Institute is an example of this, its formation having been a sequel to a simplified-practice conference at which 40 sizes of steel reinforcing bars were reduced to 11.

Another effect has been with respect to trade practices, the cohesive influence of the simplification program being to improve trade practices. In some cases it has been revealed by the surveys of variety that public esteem had been shaken by conditions within the industry; in others the effect of the movement was to further elevate standards of practice as they concerned the protection of the consumer.

Publications and Standing Committees.—The chairmen of standing committee for each of the simplified-practice recommendations are given below. Publications are available for all items on the following list except those indicated by an asterisk (*), and may be obtained from the Superintendent of Documents, Government Printing Office, at 5 cents each unless otherwise indicated. Numbers preceded by (x) indicate those published during 1926.

Simplified practice recommendation No.	Item	Chairman of standing committee	Reduction
			Per cent
1	Vitrified paving brick (fourth revision).	E. J. Mehren, McGraw Hill Publishing Co., New York, N. Y.	94
2	Beds, springs, and mattresses	George G. Powers, Union Bed & Spring Co., Chicago, Ill.	95
3	Metal lath	W. B. Turner, General Fireproofing Building Products, Youngstown, Ohio.	81
4	Asphalt (penetration)	Col. R. Keith Compton, director, department of public works, Richmond, Va.	87
5	Hotel chinaware	E. L. Torbert, Onondaga Pottery Co., Syracuse, N. Y.	77
6	Files and rasps	H. P. Sheets, secretary, National Retail Hardware Association, Indianapolis, Ind.	65
7	Rough and smooth-face brick	William Carver, secretary, Common Brick Manufacturers Association, Cleveland, Ohio.	97
	Common brick		98
8	Range boilers	Frank Sutcliffe, president, John Wood Manufacturing Co., Conshohocken, Pa.	90

Simplified practice recommendation No.	Item	Chairman of standing committee	Reduction
			Per cent
9	Woven-wire fencing	H. Sanborn Smith, first vice president, Gulf States Steel Co., Birmingham, Ala.	87
	Woven-wire fence packages		93
10	Milk bottles and caps	P. C. Doyle, American Metal Cap Co., Brooklyn, N. Y.	
	Bottles		92
	Caps		90
*10	Milk and cream bottles and bottle caps (first revision).		95
11	Bed blankets (sizes)	J. J. Pearce, Pearce Manufacturing Co., Latrobe, Pa.	85
12	Hollow building tile	K. W. Dunwody, Standard Brick & Tile Co., Macon, Ga.	48
*12	Hollow building tile (first revision).		42
13	Structural slates for plumbing and sanitary purposes.	W. S. Hays, secretary, National Slate Association, Philadelphia, Pa.	84
14	Roofing slates, descriptive terms, thickness, and sizes.	do	51
15	Blackboard slates, slab heights, and sizes.	do	90
(x) 16	Lumber (first revision)	John H. Kirby, Houston, Tex.	
17	Forged tools	W. H. Hays, Iron City Tool Works, Pittsburgh, Pa.	47
18	Builders' hardware, items, finishes.	W. A. Heizmann, Penn Hardware Co., Reading, Pa.	26, 71
19	Asbestos paper, sizes, widths, weights of rolls; asbestos mill board, sizes, thicknesses.	Standing committee to be appointed	43 50
20	Steel barrels and drums	D. S. Hunter, secretary, Steel Barrel Manufacturers Institute, Cleveland, Ohio.	64
21	Brass lavatory and sink traps	H. C. Bulkeley, American Sanitary Manufacturing Co., Abingdon, Ill.	94
22	Paper	S. L. Willson, American Writing Paper Co., New York, N. Y.	
23	Plow bolts	Col. O. B. Zimmerman, International Harvester Co., Chicago, Ill.	44
24	Hospital beds:		
	Length Width Height	Miss Margaret Rogers, superintendent, St. Luke's Hospital, St. Paul, Minn.	97 91 98
25	Hot-water storage tanks	C. C. Lanman, President, Novelty Steam Boiler Works Co., Baltimore, Md.	88
26	Steel reinforcing bars, cross-sectional areas.	M. A. Beeman, Concrete Reinforcing Steel Institute, Chicago, Ill.	73
27	Cotton duck (widths and weights).	Howard Baetjer, Mt. Vernon-Woodberry Mills (Inc.), Baltimore, Md.	80
(x) 28	Sheet steel (first revision)	W. C. Carroll, vice president, Inland Steel Co., Chicago, Ill.	85
29	Eaves trough and conductor pipe.	Louis Kuehn, Milwaukee Corrugating Co., Milwaukee, Wis.	24
30	Terneplate (weights)	L. D. Brueckel, Weirton Steel Co., Weirton, W. Va.	22
(x) 31a	Loaded shells (first revision)	C. L. Reierson, president, Remington Arms Co., New York, N. Y.	57
32	Concrete building units (length, width, and height of blocks, tile, and brick).	E. W. Dienhart, Cement City, Mich.	
33	Cafeteria and lunch-room chinaware.	E. L. Torbert, chairman, manufacturers' committee, in care of Onondaga Pottery Co., Syracuse, N. Y. A. M. Howe, chairman, distributers' committee, in care of Mitchell, Woodbury Co., Boston, Mass.	73
34	Warehouse forms	Sidney A. Smith, American Warehousemen's Association, Boston, Mass.	
35	Steel lockers	C. S. Bergert, The Berger Manufacturing Co., Canton, Ohio.	74
36	Milling cutters	C. W. Machon, Brown & Sharpe Manufacturing Co., Providence, R. I.	35
(x) 37	Commercial purchase forms	W. L. Chandler, secretary, National Association of Purchasing Agents, New York, N. Y.	
(x) 38	Sand-lime brick (length, width, and height).	J. M. Porter, Bureau of Standards, Washington, D. C.	79
(x) 39	Dining car chinaware	E. L. Torbert, chairman, manufacturers' committee, care of Onondaga Pottery Co., Syracuse, N. Y. A. M. Howe, chairman, distributers' committee, care of Mitchell, Woodbury Co., Boston, Mass.	84
(x) 40	Hospital chinaware	do	84
(x) 41	Insecticides and fungicides (packages).	Ernest T. Triggs, John Lucas & Co. (Inc.), Philadelphia, Pa.	45

Simplified practice recommendation No.	Item	Chairman of standing committee	Reduction
			Per cent
(x) 42	Paper grocers' bags	C. R. McMillen, Union Bag & Paper Corporation, New York, N. Y.	25
* 43	Paint and varnish brushes	A. S. Polk, Pittsburgh Plate Glass Co., Baltimore, Md.	71
(x) 44	Box board thicknesses	George W. Gair, Robert Gair Co., New York, N. Y.	75
(x) 45	Grinding wheels	George W. Chormann, The Carborundum Co., Niagara Falls, N. Y.	64
* 46	Tissue paper:		
	Roll tissue	Z. W. Ranck, Crystal Tissue Co., Middletown, Ohio	77
	Shoe tissue		72
(x) 47	Cut tacks and small cut nails:		
	Sizes	Herbert S. Hollans, Shelton Tack Co., Shelton, Conn.	58
	Packing weights		71
(x) 48	Shovels, spades, and scoops	J. V. Smith, Hubbard & Co., Pittsburgh, Pa.	57
(x) 49	Sidewalk lights:		
	Sizes	Davis Carpenter, Davis Carpenter Co. & (Inc.), New York, N. Y.	95
	Styles		94
	Shapes		80
(x) 50	Checks, notes, etc.	Alexander Dunbar, president, clearing house section, American Bankers' Association, New York, N. Y.	
(x) 51	Die head chasers (for self-opening and adjustable die heads).	Carl W. Bettcher, Eastern Machine Screw Corporation, New Haven, Conn.	75
* 52	Staple viterous china plumbing fixtures.	A. M. Maddock, president, Thomas Maddock's Sons Co., Trenton, N. J.	87
* 53	Steel reinforcing spirals	(No standing committee)	58
* 54	Sterling silver flatware	Edmund C. Mayo, Gorham Manufacturing Co., Providence, R. I.	67
* 55	Tinware, galvanized, and japanned ware.	W. S. Smith, Sheet Metal Ware Association, New York N. Y.	24
* 56	Carbon brushes and brush shunts.		
* 57	Wrought iron and wrought steel pipe, valves, and pipe fittings:		
	Sizes of valves and fittings		4
	Sizes of pipe		21
* 58	Classification of iron and steel scrap.		
* 59	Veneer stock for wire-bound boxes:		
	Length		94
	Width		92
	Thickness		55

BUILDING AND HOUSING

The work on building and housing seeks to promote a wider application of the best standards for building materials and design to the $6,000,000,000 of new construction which is being carried out each year. In this way it helps to widen the practical usefulness of the laboratory and field research work of the Bureau of Standards and of other scientific bodies, and to secure a more general adherence to approved specifications and simplified practice programs for elimination of excess dimensional varieties.

The advisory building code committee has been most active and influential in this field. More than $3,000,000,000 worth of construction work is carried out each year under the conditions prescribed by local building codes, and each of the committee's six reports gives concise recommendations suitable for inclusion in such codes. Each of these reports also contains an appendix which explains the recom-

mendations and offers much additional information of value to designers and builders. Thus the committee's reports disseminate knowledge as to good standards of building practice directly, as well as through encouraging more uniform local codes which permit economical construction and at the same time assure safe and durable structures.

The work has been at all times closely coordinated with that of simplified practice, in its extensive program covering more than 40 different building materials. It has cooperated with groups interested in standardizing nomenclature and units used in the sale of building materials; more uniform State mechanics' lien legislation; and greater uniformity in the State laws governing city planning and zoning measures, which endeavor to promote the proper location of buildings, streets, and public property with respect to one another, and the social and economic needs of the community.

Building Code Committee.—A large proportion of the more than $6,000,000,000 worth of construction added to the wealth of the Nation during the last calendar year was erected, as stated above, subject to a heterogeneous mass of building-code regulations. These regulations differ in various cities more because they grew up without any definite plan than because of any real difference in local conditions. The result in some places has been to force unnecessary expense upon owners, particularly home builders, and to legalize unsafe building in others. The growing body of architects and builders doing business in several cities, or throughout the country, has had to adapt itself to a new set of requirements in each community. Building cost differentials have been created between different cities which have retarded the growth of some to the advantage of others. While this is only one of several sources of waste in the building industry, it is one with which standardization can deal effectively. Definite steps are being taken to bring about more uniform and economical building regulations.

Standardization of building codes took a prominent position in the public mind as a result of the activities of the United States Senate Committee on Reconstruction and Production appointed in 1920. Salient facts brought out by this committee were that there was a wide diversity in building-code requirements; that this proceeded from unscientific methods in preparing codes, and that large savings appeared to be possible through more uniform requirements. These were facts already well known to many architects and builders, but their significance was thrown into relief by the twin evils of inadequate housing facilities and stagnant building conditions existing at the time the Senate committee's report was published.

Practical attack of the problem was commenced in 1921 through the appointment by Secretary Hoover of a committee of seven

architects and engineers of high professional standing to undertake thorough and impartial studies. The committee bore the title of Building Code Committee of the Department of Commerce. Through it and through a subcommittee on plumbing, six reports incorporating recommended code requirements have been issued.

At first the most promising method of promoting reasonable economies consistent with sound practice appeared to dictate narrowing the field of work to those features of building from which immediate results could be secured. The country needed homes. The local code requirements for such construction appeared to be in a chaotic state. The committee, therefore, struck at this vital point instead of attempting a general survey.

Recommended Minimum Requirements for Small-Dwelling Construction.—The first report, which bore the title "Recommended Minimum Requirements for Small-Dwelling Construction," was accepted by Secretary Hoover in 1923 with the following comment:

> This report has been built up by cooperation of the Government and the public, which I feel will appeal to everyone. The committee itself represents the great voluntary organizations most interested in public service in this direction, but beyond this you have consulted with many other associations, and incorporated their criticisms into its final form. I believe this method of intellectual legislation is unique and gives the report a value far beyond any similar work undertaken to date.

It presents recommendations for the construction of one and two family dwellings having exterior walls of solid or hollow masonry, concrete, and frame, the latter including veneer and stucco surfaces.

The committee recommends that building codes permit 8-inch solid brick and 6-inch solid concrete walls for two and one-half and three story dwellings accommodating not more than two families each; that 8-inch hollow building tile, hollow concrete block, or hollow walls of brick (all rolok) shall not exceed 20 feet in height to the gable; and that frame construction be limited to two and one-half stories. Metal lath and plaster on wood studs properly fire-stopped is approved for party and division walls, but at least every alternate wall in row houses must be 8-inch solid brick or concrete, or 12-inch hollow building tile, concrete block, or hollow wall of brick.

Requirements for quality of hollow masonry units agree fairly well with present practice, but those for brick are somewhat below the medium grade established by the American Society for Testing Materials. The report recommends revised working stresses for timber used in dwellings, based on investigations of the United States Forest Products Laboratory. Live loads to be required as bases for design are 40 pounds per square foot for floors of wood, and 30 for those of monolithic type, or of solid or ribbed slabs. Foundation walls of brick are required to be 12 inches thick for excavated inclosures, and similar concrete walls shall be as thick as the walls

they support, but not less than 8 inches. Special hollow building tile 12 inches thick is permitted for foundation walls for frame buildings.

Recommended Minimum Requirements for Plumbing in Dwellings and Similar Buildings.—The fact that certain practices in installing plumbing were employed successfully in some places and forbidden in others opened up another field where economies appeared possible through standardization of requirements. No careful investigation of the subject had been made up to this time. The committee decided that scientific research under the direction of experienced sanitary engineers and plumbers was necessary. Accordingly a subcommittee on plumbing was appointed by Secretary Hoover and this outlined a series of tests to be carried out at the bureau. These tests were continued over a period of more than two years and the principles deduced from them were incorporated in the subcommittee's report, "Recommended Minimum Requirements for Plumbing in Dwellings and Similar Buildings," published in 1924.

The report contains a recommended code, and, in addition, a complete report of the experiments at the Bureau of Standards, showing how the committee arrived at its recommendations.

The results indicate that present customary assumptions in the design of plumbing are considerably on the side of safety and point the way to substantial economies in future work of this sort. The committee recommends that 3-inch soil stacks be permitted in systems for dwellings; that the running or house trap now required in many cities be omitted and that a distance of not to exceed 5 feet be permitted between traps and ventilation pipes. As a result of tests with complete household systems it was found possible to eliminate much of the expensive vent piping now considered necessary. Economies possible through complete adoption of the committee's recommendations are estimated at from $50 to $100 for a two-story dwelling with the usual number of fixtures, depending on the nature of requirements now obtaining in a given locality.

Consideration was given to the much-discussed subject of plumbing code administration. The report states that, while the relation of defective plumbing to disease is much less direct than formerly believed, the subject in all its branches is not yet fully explored, and the possibility of direct access of vermin from the interiors of plumbing systems to those of buildings is sufficiently objectionable to justify public regulation of plumbing work. The committee recommends a competent official plumbing inspector under jurisdiction of public safety authorities, to examine and approve plans and specifications, test, and approve plumbing systems and take such other measures as will make his control of plumbing work effective. The advisability is suggested of substituting certificates of competency for the present

licensing system and of permitting owners to install plumbing personally, provided this is done in accordance with the code and subject to official permit and inspection.

Plumbing codes.—The following six States have adopted recommendations of the Plumbing Code Committee: Florida, Indiana, Iowa, Maine, New York, and Vermont.

Recommended Minimum Requirements for Masonry Wall Construction.—Up to this point the committee had concentrated its attention on problems connected with small homes. In the course of its investigations, however, the fact had been brought out repeatedly that masonry wall regulations for buildings of all types differed widely in various cities; that allowable masonry stresses and fire-resistance requirements were based on inadequate knowledge of service under loading and fire exposure; and that as a result there was a lack of safety in some localities and an unnecessary use of materials and labor in others. The committee, therefore, decided to prepare recommendations representing the best information obtainable on the subject.

The behavior of masonry walls is dependent upon a number of factors, no one of which can be wholly ignored in drawing up safe stress requirements. Masonry units vary in individual compression and transverse strength, depending on the locality from which they come and the method of manufacture. Absorption is another factor. Walls are built with different mortars, with different bonds, and with varying quality of workmanship. Some have a definite mission to perform in supporting the loads imposed by the structure and by their own weight while others merely serve as a protection, the weight being carried by a steel or reinforced concrete frame. All these and other considerations make the establishment of fair requirements a very complicated task. Some idea of the research necessary in the preparation of such requirements may be gained from the fact that the results of over 700 individual tests of compressive strength of brick masonry, many of them made at the bureau, were analyzed before making the recommendations for code requirements. Extensive tests of the fire resistance of various masonry materials and combinations made at the bureau and other places were also summarized and much valuable information not otherwise obtainable in concise form was presented in the committee's report "Recommended Minimum Requirements for Masonry Wall Construction," published in 1925.

This report presents a set of building code requirements for the regulation of masonry wall construction which are recommended for adoption or adaptation by those writing or revising building codes. It covers the quality of materials, maximum stresses for which masonry should be designed, matters of workmanship, and the height

and thickness of unstayed masonry walls, both bearing and nonbearing. In general, the committee's investigations disclose that thinner walls than those usually required in building codes are safe except under abnormal conditions of loading, wind pressure or seismic disturbances.

Minimum Live Loads Allowable for Use in Design of Buildings.— Early in the committee's work the question was raised of code variations regarding live loads, and efforts were made to collect data on actual loads which might be used in drafting recommendations. Investigation disclosed that very little had been published on this important subject, and showed wide variation in the minimum floor roof, and wind loads for which building codes require buildings to be designed. The extent of this variation, indicates either that safety is disregarded in many cases or that an unnecessary amount of building materials and labor is used because of these laws. It was found that live loads assumed in designing many types of buildings were largely matters of tradition and had scant scientific basis. The result was that accuracy in stress computations was defeated because of ignorance of the loads causing stresses. The building professions for years have busied themselves with tests of materials, but have given little attention to this complementary factor of loads.

With comparison of live-load requirements in over 100 existing codes, and investigations revealing actual live loads of typical occupancies before it, the committee was able to draw up a report bearing the title "Minimum Live Loads Allowable for Use in Design of Buildings." This appeared also in 1925. Wind pressures were fixed after consultation with Weather Bureau officials.

The requirements are brief and simpler of application than those of many building codes. The live load on floor space used for residential purposes, in general, is placed at 40 pounds per square foot. For office space and assembly places not subject to standing crowds 50 pounds are specified, and for other floor space in buildings for human occupancy the minimum limit is 100 pounds. Industrial or commercial buildings are to be designed primarily for the proposed occupancy and data are given in the Appendix by which loads characteristic of different occupancies may be approximated. Roof and wind load requirements are somewhat less than present code practice, with emphasis on the influence of local conditions. Allowance is required in certain buildings for movable partition loads, and floor-to-floor reduction is permitted in transmitting the assumed live loads in high buildings to the footings.

Provision is made for posting of allowable loads in commercia and industrial buildings and for rigid inspection and regulation of occupancy change through requirement of occupancy permits.

The report gives extensive data on the live loads found in hospitals, schools, offices, assembly places, and commercial and industrial buildings for various purposes, including factories, warehouses, and garages. Results of impact due to moving crowds also are presented.

Recommended Building Code Requirements for Working Stresses in Building Materials.—In spite of the fact that a considerable body of test data had grown up on the strength of materials, building codes presented the same picture of variety in working stress requirements that they did in less technical matters. Apparently this was due to the influence of tradition and failure to keep abreast of improvements in materials, design, and methods of construction. Following the same course of careful research and expert advice, the committee has drawn up recommendations for working stresses in reinforced concrete, cast iron, steel, and timber. It has drawn freely upon the existing recommendations of such bodies as the joint committee on concrete and reinforced concrete, the American Institute of Steel Construction, and the Forest Products Laboratory, departing from them chiefly where the known state of building supervision seemed to require variations.

Outstanding features of this report, which was published in 1926, are the adoption of the water-cement ratio as a means of controlling the ultimate strength of concrete; an allowable $\frac{L}{r}$ of 90 for cast-iron columns; a basic stress of 18,000 pounds per square inch for steel when the material conforms to A. S. T. M. Standard Specifications for Structural Steel for Buildings, and a revised table of timber stresses conforming to the basic grading rules of the American Lumber Standards and derived by methods recently developed at the Forest Products Laboratory.

Emphasis is placed upon competency of design, and the desirability from an economic standpoint of increased personnel and facilities for building inspection.

Use of Reports in Local Codes.—The question naturally arises, how far has standardization of local building codes proceeded as a result of the committee's work? An incomplete survey shows that its reports have been utilized in whole or in part by 71 municipalities in 29 States when revising their building codes. Bearing in mind that the work has been going on but 5 years, that some of the reports are very recent, and that municipalities give their codes a thorough overhauling at intervals variously estimated at from 5 to 10 years, the results are very encouraging. There are already indications that the force of example is tending to accelerate the process and that the next five years will witness larger gains.

Standardized Price Quotations.—Standards of comparison of retail building material prices in cities throughout the country had been

very difficult to establish in the past because of lack of uniformity in the form of quotations and failure of any centralized impartial source to obtain quotations on a comparable basis. By obtaining prices monthly of some 24 items in about 50 cities and publishing them, reasonable standards of comparison have been set up, and it is hoped that the work may lead to more uniform practice in regard to the nomenclature and units used in the sale of building materials.

Mechanics' Lien Legislation.—The Department of Commerce is sponsoring a committee representing business and professional groups, which is attempting to draft a uniform State mechanics' lien act. The need for such an act arises from a lack of uniformity in existing State acts, which all have as their object the remedy of abuses of unsatisfactory credit relations which are found in the construction industry in nearly every community. Here again it is believed that a careful study of the ills to be remedied, and of the nature of a fair solution, will result in the prevention of ill-adapted legislation.

City Planning and Zoning.—The rapid development of city zoning which means the dividing of cities into classes of districts in which the height of buildings, the area of the lot which they may cover, and the use to which they may be put are regulated, raised a number of problems which vitally affected the welfare of home owners, land owners, commercial and industrial interests, and civic welfare throughout the country. It was felt that there would be a tremendous gain if the movement could be guided along lines which had proved sound in practice and in conformity with constitutional law. An advisory committee on city planning and zoning was appointed by the Secretary of Commerce, which drafted a standard city zoning enabling act. This act has been used wholly or in large part in at least 20 States, and as a result a tremendous amount of litigation has been avoided, and zoning has been strongly influenced to follow sound and reasonable lines. More than 450 municipalities, comprising more than half the total urban population of the country, have adopted zoning ordinances, more than 370 having done so since January 1, 1922.

The growing need for control of street layout in the growing sections of cities and of more wisely planned expenditure of public funds for highways, public works of all types, and public buildings, and the desirability of better consideration by private owners of the probable course of city development, also has led to a much wider demand for soundly guided city planning. The advisory committee on city planning and zoning has accordingly drafted a standard city-planning enabling act. This enables cities to appoint planning commissions to be organized along lines found by experience to be most advantageous and to control the layout of new subdivisions by private developers of land. It represents some distinct advances

36316—27——19

in methods for controlling the small minority of such developers who are not willing to work in friendly cooperation with planning authorities, and also lays the groundwork for the development of regional planning. The standards for the State legislation involved are not derived from physical constants and test data, but in some respects they are subject to the same type of approach as building codes. The elucidation of certain legal and practical fundamentals, based on study of conditions in many States and cities is of great help to individuals who are trying to solve local problems. Good planning and zoning makes for stability in the suitable use of urban land, and thereby helps to eliminate waste from the scrapping of structurally sound buildings which has been so prevalent in American cities, and provides a stronger incentive for sound and durable construction.

Lists of zoned municipalities and of State zoning enabling acts have been compiled from time to time, commencing in January, 1923. These lists have been reprinted widely in periodicals and the daily press, as well as in the yearly Municipal Index for 1924, 1925, and 1926. The latest list is available in mimeographed form. The members of the advisory committee on city planning and zoning have contributed many articles to the published proceedings of the National Conference on City Planning, and the city-planning division of the American Society of Civil Engineers, and for other organizations and periodicals.

Zoning enabling acts.—The following 20 States have adopted "a standard State zoning enabling act," wholly or in large part:

Arizona.	Iowa.	Oklahoma.
Colorado.	Louisiana.	Pennsylvania.
Delaware.	Nevada.	Rhode Island.
Florida.	New Hampshire.	South Carolina.
Georgia.	New Jersey.	Utah.
Idaho.	North Carolina.	Wyoming.
Illinois.	North Dakota.	

TESTING

Testing is a primary service of the bureau to insure acceptable quality and quantity of a vast amount of Government purchases, and to meet demands for which private laboratories are not equipped. Testing is the final check for conformity to standard and constitutes the major means of securing benefit from standards. The bureau supports branch testing laboratories at Northampton, Pa., Columbus, Ohio, Denver, Colo., and San Francisco, Calif.

Fundamental tests are those of standards for industry or science. For this the bureau is the only laboratory having direct access to

the fundamental national standards, and its facilities for such tests are unique.

Routine tests of measures, devices, and materials are the more numerous. About two-thirds of such work is for the Government. Such tests are made for the public only when they do not compete with private laboratories.

Referee tests are made by the bureau in important cases when the parties to a dispute agree to abide by the decision.

Cooperative tests are made where the results are of mutual concern. The results are open to the public. When done for a manufacturer to assist in improving his product, a nominal fee is charged.

The bureau made 138,000 tests of all kinds during the year, having a fee value of about $380,000.

VII. MUNICIPAL AND STATE AGENCIES

Although the governments of the States and municipalities purchase great quantities of materials, and a considerable amount of standardization has taken place in their purchase requirements, there is a very wide diversity in their methods of formulating specifications and placing contracts. Some information concerning these various methods is given in the present chapter.

MUNICIPAL PURCHASING AND STANDARDIZING AGENCIES

General purchasing agencies have been established in a number of cities. In Minneapolis each city department draws up its own specifications for purchases to be made by the city purchasing agent, who is appointed by the civil service commission. In Jersey City the general purchasing agent, appointed by the board of city commissioners, prepares specifications and proposals for the purchase of all commodities used by the city except the specifications for fire engines, street paving, and cleaning which are prepared by the city's engineering department. Specifications are prepared by the Dallas city purchasing agent for approval by the city commission, consisting of the mayor and four commissioners.

The chief buyer of Milwaukee purchases all materials, supplies, and equipment for the city government, upon specifications prepared by him in cooperation with the city paving chemist and city department engineers. Upon the purchasing division of the New Orleans department of public finances falls the duty of selecting specifications and making purchases for materials, supplies, and equipment for use by the city government. In Akron the purchasing agent prepares the specifications and places all contracts for materials under $1,000, and he makes recommendations for purchases exceeding this amount, the contracts for which are let by the city's board of control.

A bureau of standards has been organized by the city of Baltimore to formulate standards and specifications and recommend, but not compel, their use by the city departments and bureaus. Standards have been set up for fuel, lubricants, paper, and soap, and numerous kinds of building materials, special effort being made to have the specifications conform to the most recent specifications of the American Society for Testing Materials and the Federal Specifications Board whenever possible.

The bureau of standards of the city of Portland is conducted under the authority of the department of public works. It co-

operates with the other city bureaus in the selection and adoption of specifications and checks the delivery of materials purchased under specifications. With the bureau of buildings rests the responsibility for the enforcement of the city's "building code" issued by the department of public works.

The charter of the city of St. Louis provides for the creation of a board of standardization, consisting of the comptroller, who is elected by the people; the supply commissioner, who is appointed by the mayor; and the president of the board of public service, also appointed by the mayor. Specifications are drawn up by the board of standardization after study has been made of existing nationally recognized specifications for the commodities. Specifications have already been formulated for food stuffs, fuel, fire hose, and paving and building materials. Contracts are let by the board of public service for street construction, buildings, etc.

In the city of Detroit the street railways are operated by the municipality. Both the department of street railways and the department of purchases set up standards, the former for all materials used in railway construction and maintenance, and the latter for supplies used by the other city departments. A committee consisting of the mayor, the city controller, and the purchasing commissioner formulates the standards and adopts specifications for the purchase of materials for the city.

Cincinnati has the city-management form of government. The city manager, appointed by the city council, exercises control over the safety department and the service department of the city, and cooperates with the board of health, the board of park commissioners, and the rapid transit commission in the preparation of specifications. Each department of the city formulates its own specifications which are coordinated by the city manager in consultation with other departments having similar functions.

Other municipalities having the city-management form of government operate in a somewhat similar manner, for example: Pasadena, Calif.; Durham, N. C.; Norfolk, Va.; Portsmouth, Va.; Roanoke, Va.

In Los Angeles there are three agencies concerned with the purchase of commodities under specifications: The city purchasing agent, the purchasing agent for the harbor department, and the purchasing agent for the department of water and power. The last-mentioned department has authority to compile or select specifications and make purchases for all materials, supplies, equipment, etc., for use by the bureau of water works and supply and the bureau of power and light, which two bureaus comprise the department. The city purchasing agent formulates specifications and makes purchases for all departments except those earning their own revenues.

Among the municipalities, New York City has formulated and utilized the greatest number of purchase specifications, more than 1,600 specifications for 42 different classes of commodities having been prepared for this purpose. Practically all of the work of standardization is done in the department of purchase, the head of which is appointed by the mayor.

Recommendations for standards are forwarded to the board of estimate and apportionment, which consists of the mayor, the comptroller, the president of the board of aldermen, and the five borough presidents, all of whom are elected officials. Standards adopted by this board are compulsory on all city departments.

A considerable amount of effective standardization has been carried forward by the school boards in numerous localities. In Cleveland the board of education has established a bureau of standards to secure agreement on standard schedules of equipment and supplies required for the schools and make recommendations as to the standardization of all articles in the schedules for the approval of the board's committee on housing and supplies.

STATE PURCHASING AND STANDARDIZING AGENCIES

In every one of the 48 States, standards for materials used in the construction and maintenance of roads and bridges have been established by the State highway commissioners. Much of the present activity in this line of standardization can be attributed to the aid given to the States by the Federal Government for the building of the main highways of the country. The specifications used by the commissions as best suited for the local climatic and traffic conditions and sources of supply of materials are in conformity with the specifications formulated by the American Society for Testing Materials, the American Association of State Highway Officials, and the United States Bureau of Public Roads, and formally approved by the United States Secretary of Agriculture for use in connection with Federal-aid road construction.

With few exceptions the State highway commissions are appointed by the governor usually with the advice and consent of the senate. Members of the Mississippi State highway department are elected by popular vote, and the State highway commissioner of Michigan is also elected.

A considerable number of the State governments have organized centralized purchasing agencies or adopted uniform specifications, in all cases independent of the State highway commissions. Condensed outlines of the standardization activities of the agencies, with addresses of their headquarters and of the headquarters of the highway commissions and the names of the officers in charge are given below.

Where symbols are used after the name and address of the agency or body they have the following significance:

(*b*) = Name and title of officer in charge.
(*c*) = Body appointed by.
(*d*) = Authority of body.
(*e*) = Procedure in formulating specifications.
(*f*) = Types of commodities for which specifications have been prepared.

Alabama State Board of Control and Economy, Mongtomery. Appointed by the governor to formulate specifications and make purchases for all State departments and for the smaller State institutions.

Alabama State Highway Department, Montgomery. John A. Rogers, chairman.

Arizona Board of Directors of State Institutions, Phoenix. George W. P. Hunt, president. Board is composed of the governor, the State treasurer, and a member appointed by the governor, to approve specifications recommended by the State purchasing agent for all State institutions including the State highway department, but not including the State schools.

Arizona Highway Department, Phoenix. W. C. Lefebvre, State engineer.

Arkansas State Purchasing Department, Little Rock. H. A. Emerson, purchasing agent. Department was organized by the governor to prepare specifications, supervise erection of buildings for State institutions, and purchase supplies for the institutions.

Arkansas State Highway Commission, Little Rock. Herbert R. Wilson, chairman.

California State Division of Purchases and Custody, Sacramento. (*b*) George G. Radcliff, chief. (*c*) Governor. (*d*) Formulate specifications and make purchases for all State departments and institutions unless exempted by the State board of control. (*e*) Specifications prepared by the State purchasing agent.

California Highway Commission, Sacramento. Harvey M. Toy, chairman.

The Associated Purchasing Agents of the Colorado State Educational Institutions, Boulder. (*b*) Henry B. Abbett, chairman. (*c*) Consists of purchasing agents of State-owned institutions. (*d*) Standardize on commodities that may be used in common by the State educational institutions; pool the requirements and make purchases for the institutions. (*e*) Studies are made of United States Government master specifications and other nationally recognized specifications to select those best suited for the needs of the institutions. (*f*) No specifications have as yet been prepared or formally adopted, although many of the requirements have been pooled.

Colorado State Highway Department, State Office Building, Denver. Louis D. Blauvelt, State highway engineer.

Connecticut State Highway Commission, Hartford, John A. MacDonald, State highway commissioner.

Delaware State Board of Supplies, Dover. (*b*) Sylvester D. Townsend, secretary of board. (*c*) Composed of governor, State treasurer, and two electors appointed by the governor with the consent of the senate. (*d*) Formulate specifications and contract for current stationery and miscellaneous supplies and printing for all State departments and institutions.

Delaware State Highway Department, Dover. F. V. du Pont, chairman.

District of Columbia Purchasing Office, Washington, D. C. (*b*) M. C. Hargrove, purchasing officer. (*c*) Commissioners of the District of Columbia. (*d*) Formulate or select specifications and make purchases for all departments and institutions of the District government. (*e*) and (*f*) Utilize specifications

promulgated by the Federal Specifications Board. Supplies not covered by these specifications are usually purchased on the sample basis.

Florida Board of Commissioners of State Institutions, Tallahassee. Appointed by the governor to formulate and adopt specifications and make purchases for all State institutions. Specifications are prepared by the purchasing agent for approval by the board.

Florida State Road Department, Tallahassee. Fons A. Hathaway, chairman.

Georgia State Highway Department, Box 147, East Point. John N. Holder, chairman.

Idaho Department of Public Works, Bureau of Supplies, Boise. (*b*) R. G. Archibald, State purchasing agent. (*c*) By the commissioner of public works. (*d*) Formulate and adopt specifications for all State departments and State institutions.

Idaho State Bureau of Highways, 205 State House, Boise. H. W. Gregory, director of highways.

Department of Purchases and Construction, Division of Purchases and Supplies, Springfield. (*b*) L. H. Becherer, State purchasing agent. (*c*) By the governor with the approval of the senate. (*d*) Formulate and adopt specifications for all State departments and all penal, reformatory, and charitable institutions, and normal schools.

Department of Public Works and Buildings, Division of Highways, Springfield. Frank T. Sheets, chief highway engineer.

Indiana State Joint Purchasing Committee, Indianapolis. (*b*) Daily E. McCoy, secretary. (*c*) Body selected by a majority vote of institution heads. (*d*) Has authority to make purchases for State charitable and correctional institutions. (*e*) Specifications are formulated by a subcommittee of the purchasing committee. (*f*) Chinaware, glassware, table cutlery, paints, oils, varnishes, dry goods and notions, groceries and laundry supplies, coal, gasoline, oils and greases, yeast, automobile tires and batteries, and electric light globes.

Indiana State Highway Commission, Indianapolis. Charles W. Zeigler, chairman.

Iowa State Purchasing Department, State capitol, Des Moines. (*b*) H. L. Shropshire, purchasing agent. (*c*) Board of control of State institutions. (*d*) Formulate specifications, secure bids, and award contracts, subject to the approval of the board of control (*e*) and (*f*) Standard specifications have been prepared for supplies required by the State institutions.

Iowa State Highway Commission, Ames. F. E. White, chief engineer.

Kansas State Board of Administration, Topeka. (*b*) T. J. O'Neil, business manager. (*c*) Composed of governor and three electors appointed by him. (*d*) Formulate specifications and make purchases for all State institutions. (*e*) Specifications are prepared by the business manager for approval of the board of administration. (*f*) Dry goods, groceries, meats, hardware, electrical supplies, stationery, drugs, and queensware.

Kansas State Highway Commission, Topeka. John W. Gardner, chairman.

Kentucky State Board of Charities and Corrections, Frankfort. (*b*) J. E. Robinson, chairman. (*c*) By the governor with the consent of the senate. (*d*) Establish specifications for public institutions. (*e*) Specifications are prepared by commissioner of public institutions for approval of board of charities and corrections. (*f*) Meats, groceries, dry goods, clothing, shoes, tableware, fuel, and lubricants.

Kentucky State Highway Commission, Frankfort. E. N. Todd, State highway engineer.

Louisiana State Board of Commissioners of the Port of New Orleans, New Orleans. (*b*) Col. Marcel Garsaud, general manager, N. B. Rhoads, supervisor

of purchases. (*c*) Commission of five men appointed by the governor. (*d*) Administer the affairs of the port of New Orleans. (*e*) Specifications formulated by the engineering department in cooperation with the purchasing department. Use is made of specifications of the Federal Government and the American Society for Testing Materials when applicable. (*f*) Building materials, rubber goods, fuel, paint, conveyer belts, etc.

Louisiana Highway Commission, Baton Rouge. W. E. Atkinson, chairman.

Maine State Purchasing Agents Association, Augusta. (*b*) Samuel N. Tobey, secretary. (*c*) Purchasing agents of State-owned institutions. (*d*) Standardize on commodities that may be used in common by the State institutions and make purchases for the institutions.

Maine State Highway Commission, Augusta. Paul D. Sargent, chief engineer.

Maryland State Central Purchasing Bureau, Whitaker Building, Baltimore. (*b*) Walter N. Kirkman, State purchasing agent. (*c*) Members of central purchasing bureau are heads of institutions and large departments, specified by law. (*d*) Determine and formulate standards of all materials, supplies, merchandise, and articles of every description to be purchased for the using authorities of the State. (*e*) Meetings are held from time to time to consider commodities to be standardized. (*f*) Fuels, food products, and laundry supplies.

Maryland State Roads Commission, Garrett Building, Baltimore, Md. J. N. Mackall, chairman and chief engineer.

Massachusetts State Department of Mental Diseases, Room 109, State House, Boston.(*b*) George M. Kline, M. D., commissioner. (*c*) By the Governor. (*d*) Standardize for 15 institutions, hospital construction, equipment, food, and other supplies and administrative procedure. (*e*) Committee of institutions' superintendents or stewards, may or may not be appointed to sit with or report to the commissioner. Decision of the commissioner is final. (*f*) Printed forms, administrative reports, foods, institution requirements, plumbing fixtures, beds and other equipment and supplies, layout, etc.

Massachusetts State Department of Public Works, Division of Highways, State House, Boston. William F. Williams, commissioner of public works.

Massachusetts State Purchasing Bureau, State House, Boston. (*b*) George J. Cronin, State purchasing agent. (*c*) Heads of various State departments. (*d*) Recommend to State purchasing agent articles which can be used in common by all State departments. (*e*) When it is found that standardization is expedient, the State purchasing agent requests the heads of the departments to designate representatives to advise him in regard to standards. (*f*) Such items as groceries, fodder, cleaning materials, clothing, rubber footwear, tires, etc.

Michigan State Administrative Board, Accounting and Purchasing Division, Lansing. (*b*) Fred B. Perry, director of accounting and purchasing. (*c*) By State administrative board organized by legislative action. (*d*) Formulate specifications and make purchases for all State departments and institutions except Michigan State College of Agriculture and Applied Science and University of Michigan. (*e*) Specifications are prepared by the director of accounting and purchasing. Uniform accounting system established and carried out under his supervision for all State departments and institutions except as above.

Michigan State Highway Department, Lansing. Frank F. Rogers, State highway commissioner.

Minnesota State Department of Public Institutions, Bureau of Purchases, St. Paul. (*b*) John Coleman, chairman. (*c*) By the governor. (*d*) Establish specifications and make purchases for 18 State charitable and eleemosynary institutions. (*e*) Specifications prepared by the purchasing agent for the approval of the board of control. (*f*) Foodstuffs, laundry supplies, textiles,

footwear, rubber hose, brushes and brooms, paints, hardware, clothing, blankets, beds, mattresses and pillows, and shade cloth and window shades.

Minnesota State Highway Department, St. Paul. G. M. Babcock, commissioner of highways.

Mississippi State Highway Department, Jackson. J. C. Roberts, chairman.

Missouri State Highway Commission, Capitol Building, Jefferson City. Theodore Gary, chairman.

Montana State Purchasing Department, Helena. (*b*) J. E. Murphy, State purchasing agent. (*c*) By the governor. (*d*) Formulate specifications and make purchases for all State departments and institutions. (*e*) Specifications prepared by the State purchasing agent for approval of the governor.

Montana State Highway Commission, Helena. Henry Good, chairman.

Nebraska State Board of Control, Lincoln. (*b*) E. B. Fairfield, secretary. (*c*) By the governor with consent of the senate. (*d*) and (*e*) Formulate specifications for supplies for all penal, charitable, and educational institutions except State university and normal school.

Nebraska State Department of Public Works, Lincoln. Roy L. Cochran, State engineer.

Nevada State Department of Highways, Carson City. George W. Borden, State highway engineer.

New Hampshire State Purchasing Department, Concord. (*b*) W. A. Stone, purchasing agent. (*c*) By the governor. (*d*) Formulate specifications. (*e*) and (*f*) Specifications are formulated, or selected, by the purchasing agent from various sources.

New Hampshire State Highway Department, Concord. F. E. Everett, State highway engineer.

New Jersey State House Commission, Trenton. (*b*) A. Harry Moore, Governor of New Jersey. (*c*) Body consists of governor, State treasurer, and State comptroller, ex-officio. (*d*) Establish standards, determine the relation thereto of articles furnished, and use State or other public or private laboratories for this purpose. (*e*) In cooperation with advisory board, composed of one representative of each State using agency, establishes standards and specifications for purchases to be made by the State purchasing agent. (*f*) Furniture, equipment, materials, supplies, printing, and stationery.

New Jersey State Highway Commission, Broad Street Bank Building, Trenton. Gen. Hugh L. Scott, chairman.

New Mexico State Highway Department, Santa Fe. James A. French, State highway engineer.

New York State Department of Purchase, Albany. (*b*) Frank R. Utter, superintendent of purchase. (*c*) By the governor. (*d*) Make purchases for all State agencies. (*e*) Standards and specifications formulated by the New York State bureau of standards. (*f*) Food products, fuel, lubricants, textiles, rubber goods, paper, builders' hardware, road materials, etc.

New York State Department of Public Works, Bureau of Highways, Albany. Arthur W. Brandt, commissioner.

North Carolina State Highway Commission, Raleigh. Frank Page, chairman.

North Dakota State Board of Administration, Purchasing Department. (*b*) M. E. MacIntyre, State purchasing agent. (*c*) By the board of administration. (*d*) Formulate specifications and make purchases for State institutions and all office supplies for State departments. (*e*) Specifications prepared by the State purchasing agent for approval of the board of administration.

North Dakota State Highway Commission, Bismarck. Governor Arthur G. Sorlie, chairman, H. C. Frahm, chief engineer and secretary.

Ohio State Department of Finance, Purchases and Printing Division, Columbus. (*b*) John P. Brennan, superintendent of purchases and printing. (*c*) By the director of finance with the approval of the governor. (*d*) Formulate specifications and make purchases for all State departments and institutions except the department of highways and public works. (*e*) Specifications are prepared by the superintendent of purchases and printing in conjunction with the department director and in cooperation with departmental officers.

Ohio State Department of Highways and Public Works, Columbus. George F. Schlesinger, director.

Oklahoma State Board of Public Affairs, Oklahoma City. (*b*) Carl L. Rice, chairman. (*c*) By the governor with the consent of the senate. (*d*) Formulate and adopt standard specifications and make purchases for all State departments and institutions except agricultural schools and the department of agriculture. (*e*) Specifications are prepared by the board. (*f*) Dry goods, groceries, oil, coal, etc.

Oklahoma State Highway Commission, Oklahoma City. Cyrus S. Avery, chairman.

Oregon State Board of Control, Salem. (*b*) Carle Abrams, secretary. (*c*) Consists of the governor, secretary of state, and State treasurer, ex officio. (*d*) Formulate specifications and make purchases for State departments and institutions. (*e*) Specifications prepared by the secretary for approval by the State board of control. (*f*) All commodities required by State departments and institutions.

Oregon State Highway Commission, Salem. R. A. Klein, State highway engineer.

Pennsylvania State Bureau of Standards and Purchases, Harrisburg. (*b*) Walter G. Scott, director of standards and purchases. (*c*) State department of property and supplies. (*d*) Formulate and establish standards and specifications for all articles, materials, and supplies to be approved by the administrative departments, boards, and commissions, and by State institutions. (*e*) A conference of representatives of the different departments, boards, and commissions, and State institutions, called periodically, is divided into committees for the purpose of establishing and accepting standards and specifications. Wherever possible the specifications as established by the Federal Specifications Board are accepted and followed by the above conference. (*f*) Textiles, groceries, dairy products, meats, general office supplies, furniture, and numerous items of equipment.

Pennsylvania State Department of Highways, Harrisburg. Paul D. Wright, secretary of highways.

Pennsylvania State Stewards Association, care of Warren State Hospital. Warren. (*b*) H. A. Ross, president. (*c*) Created at the request of the governor. (*d*) Association is composed of the superintendents and stewards of the State institutions, hospitals, and normal schools organized to discuss problems relating to institutional operation, and develop specifications for the approval of the State departments of welfare, public instruction, and properties and supplies, for use by State-owned institutions. United States Government master specifications are adopted when promulgated by the Federal Specifications Board. (*e*) No formal procedure has been adopted. (*f*) Foodstuffs, feeds, fertilizer, footwear, dry goods, and clothing.

Rhode Island State Public Welfare Commission, Purchasing Department, Providence. (*b*) C. W. Arnold, State purchasing agent. (*c*) By the State public welfare commission. (*d*) Formulate specifications and make purchases for penal, correctional, and charitable institutions under State board, and for any department upon request. (*e*) Specifications prepared by the State purchasing agent for approval of the public welfare commission. (*f*) Beef, pork, lamb,

mutton, provisions, butter, oleomargarine, cheese, lard, compound lard, coal, and gasoline.

Rhode Island State Board of Public Roads, Providence. Abram L. Atwood, chairman.

South Carolina State Highway Department, Columbia. Ben M. Sawyer, chief highway commissioner.

South Dakota State Department of Finance, Division of Purchasing and Printing, Pierre. (*b*) E. U. Berdahl, director. (*c*) State secretary of finance, who is appointed by the governor. (*d*) Act as purchasing agent for all State departments, boards, and institutions. (*e*) Standards and specifications formulated in cooperation with the board of charities and corrections, the board of regents, the State engineer, the State chemist, the highway engineers, and the several departments. (*f*) Specifications for printing, stationery, office supplies, office furniture, and equipment have been completed. Work is in progress on specifications for foodstuffs, clothing and dry goods, paints, janitor and laundry supplies, and lubricating oils.

South Dakota State Highway Commission, Pierre. Gov. W. J. Bulow, chairman.

Tennessee State Department of Finance and Taxation, Division of Purchasing, Nashville. (*b*) Joel B. Fort, State purchasing agent. (*c*) By the commissioner of finance and taxation. (*d*) Select specifications and make purchases for all State departments and institutions. (*e*) Specifications are prepared by a committee on standardization composed of representatives of each State agency using supplies for approval of the commissioner of finance and taxation.

Tennessee State Department of Highways and Public Works, Nashville. C. N. Bass, commissioner.

Texas State Board of Control, Division of Purchasing, Austin. Members of the division are appointed by the board of control to formulate specifications and make purchases for all State departments and institutions except State prisons. The specifications are prepared by the chief of the division of purchasing for approval of the board of control.

Texas State Highway Department, Austin. Eugene T. Smith, chairman.

Utah State Department of Finance and Purchase, Salt Lake City. (*b*) P. A. Thatcher, director. (*c*) By the governor. (*d*) Formulate specifications and make purchases for all State departments. (*e*) Specifications prepared by the director for approval of the department of finance and purchase.

Utah State Road Commission, Salt Lake City. Henry H. Blood, chairman.

Vermont State Department of Finance, Purchasing Department, Montpelier. (*b*) William H. Dyer, State purchasing agent. (*c*) By the governor. (*d*) Formulate specifications and make purchases for all State departments and institutions except supplies for military department. (*e*) The specifications are prepared by the State purchasing agent.

Vermont State Highway Board, Montpelier. Charles W. Gates, chairman.

Virginia State Purchasing Commission, Richmond. (*b*) Charles A. Osborne, State purchasing agent. (*c*) By the governor. (*d*) Formulate specifications for all State departments and institutions, but purchases by the purchasing agent are optional with the State departments and institutions. (*e*) Specifications prepared by the State purchasing agent for approval of the purchasing commission.

Virginia State Highway Commission, Richmond. H. G. Shirley, chairman.

Washington State Department of Business Control, Division of Purchasing, Olympia. (*b*) H. D. Van Eaton, supervisor of purchasing. (*c*) By the director of business control. (*d*) Formulate specifications and make purchases for all

State departments and institutions. (*e*) Specifications are prepared by the supervisor of purchasing in conjunction with the director of business control.

Washington State Highway Department, Olympia. J. W. Hoover, State highway engineer.

West Virginia State Board of Control, Purchasing Department, Charleston. (*b*) C. A. Jackson, State purchasing agent. (*c*) By the governor with the consent of the senate. (*d*) Formulate specifications and make purchases for all State institutions, and, upon specific request, for the State departments. (*e*) Specifications are prepared by the State purchasing agent in conjunction with board colleagues. (*f*) Food and clothing items.

West Virginia State Road Commission, Charleston. C. P. Fortney, chairman.

Wisconsin State Board of Control, Madison. (*b*) John J. Hannan, secretary. (*c*) By the governor with the consent of the senate. (*d*) Formulate specifications and make purchases for all charitable, curative, and penal institutions. (*e*) Specifications are prepared by reference to Federal standards and to other available specifications. (*f*) Groceries, meat, canned goods, blankets, and tires.

Wisconsin State Highway Commission, Madison. Al. C. Anderson, chairman.

Wyoming State Board of Supplies, Cheyenne. (*b*) Board composed ex officio of a body of three, State auditor, State treasurer, and State engineer. (*c*) Auditor and treasurer elected by popular vote, engineer appointed by the governor. (*d*) Formulate specifications and make purchases for all State departments and institutions except the highway department and the State university. (*e*) Specifications are prepared by the State engineer for approval of the board of supplies.

Wyoming State Highway Department, Cheyenne. S. W. Conwell, chairman.

VIII. GENERAL STANDARDIZING AGENCIES

In Chapter V have been given outlines of the standardizing agencies of the Federal Government, including the Federal Specifications Board; in Chapter VI the standardization work of the National Bureau of Standards has been presented briefly, and that of the State and municipal purchasing agencies has been set forth in Chapter VII. Much standardization work is being conducted by trade associations and technical societies in connection with their other activities. Outlines of their standardization activities are given in Chapter IX.

A limited number of organizations have been created for the sole purpose of carrying on the work of standardization, or work directly related thereto, namely, the American Engineering Standards Committee, which serves as the clearing house for industrial standardization, and the American Marine Standards Committee, the American Society for Testing Materials, and the Central Committee on Lumber Standards, the functions of which are fairly well indicated by their titles.

Outlines of the standardization activities of these organizations are given in the present chapter.

AMERICAN ENGINEERING STANDARDS COMMITTEE

In recognition of the need for some method to prevent duplication in standardization work and promulgation of conflicting standards, the American Institute of Electrical Engineers, the American Institute of Mining Engineers, the American Society of Civil Engineers, the American Society of Mechanical Engineers, and the American Society for Testing Materials appointed a special joint committee to formulate a method of cooperation in formulating standards. This committee held its first meeting on January 17, 1917. The result of this and subsequent meetings was the organization of the American Engineering Standards Committee, made up initially of representatives of these five societies. In 1918 the United States Government Departments of War, Navy, and Commerce designated representatives, and in 1919 the constitution was broadened to permit the representation of other national bodies.

Organized as the national clearing house for engineering and industrial standardization, the committee serves as the agency through which standardization by associations, societies, and govern mental agencies is passing to the stage of standardization on a broadly national scale. The committee also acts as the official channel of cooperation in international standardization and provides an information service on engineering and industrial standardization matters. It maintains headquarters in the Engineering Societies Building, 29 West Thirty-ninth Street, New York, N. Y. Dr. P. G. Agnew is the secretary.

Functions.—The American Engineering Standards Committee itself, usually referred to as the main committee, is primarily an administrative and policy-forming body. It does not concern itself with the technical details of a standard offered for approval, but considers the procedure followed in the formulation of the standard, the adequacy of the representation of the various interests concerned on the sectional committee organized by the sponsor body to formulate the standard, and the action by which the standard has been adopted by the sectional committee and approved by the sponsor.

Sectional Committee Method.—The sectional committee is made up of representatives officially designated by the various bodies interested in the particular standardization project in hand. In order to provide for well-balanced sectional committees, the individual members are classified according to their principal business affiliations. In the case of most specifications a classification of the interests concerned into producers, consumers, distributers, and general interests has been found sufficient. In the matter of safety codes conditions are more involved, and it is usually necessary to provide for the representation of six distinct groups. The A. E. S. C. assures itself that the personnel and composition of each sectional committee are authoritative and adequately representative of the various interests concerned in the standard or group of standards for the formulation of which the sectional committee is responsible.

A. E. S. C. Approval.—Approval of a standard by the A. E. S. C. means, not that the main committee has itself worked over and passed upon the technical details of the standard, but that it has satisfied itself that all organizations concerned have had an opportunity to participate in the work, that the work has been carried out under a procedure that has been regular, open, and aboveboard, and that the standard represents a real national consensus on what is best in American engineering and industrial practice. An existing standard may be approved by the A. E. S. C. if it has been developed substantially in accordance with A. E. S. C. rules of procedure, or has by actual practice proved its right to become a standard.

Initiation of Projects.—Work upon a standardization project is undertaken by the A. E. S. C. only upon a formal request from a responsible body, and then only after the committee has assured itself that it is the desire of industry that the work shall go forward. A formal conference or a special committee of representatives of the bodies concerned with the proposed project is asked to decide (1) whether the work shall be undertaken; (2) if so, what its scope shall be; (3) how the work shall be organized; (4) how it is to be related to any other work having an important bearing on it.

Correlating Committees.—Advisory committees have been organized to suggest subjects for standardization and determine the desirability of standardization in several lines of industry, recommend sponsors, define and limit the scope of projects, adjust conflicts, clear up ambiguities, follow up and expedite work in progress in the

development of standards, and report from time to time upon progress within their fields of activities. Two such committees are now functioning, the mining standardization correlating committee and the safety-code correlating committee, and a similar committee in the electrical field has been organized as the result of formal proposals made by the American Institute of Electrical Engineers and the Electrical Manufacturers' Council. A similar step has been taken for the mechanical field by the American Society of Mechanical Engineers.

Sponsorship.—When the development of a proposed standard seems desirable the A. E. S. C. designates a sponsor or joint sponsors for the work. The sponsor organizes the sectional committee, is responsible for seeing that the work is continuously prosecuted, and provides for the publication of the standard. The relation of sponsor to the other cooperating bodies officially represented on the sectional committee is somewhat similar to the relation of the chairman to the other members of a committee. The A. E. S. C. will not approve the recommendations of any sectional committee without the previous approval of the sponsor or joint sponsors to which the sectional committee makes its report.

Government Cooperation.—Six executive departments of the Federal Government, Agriculture, Commerce, Interior, Labor, Navy, and War, and one independent establishment, the Panama Canal, are represented on the A. E. S. C. Thirty-three branches of the Government are officially represented on sectional committees. The National Bureau of Standards is acting as sole or joint sponsor for 13 projects, the Bureau of Mines for 7, the Forest Service for 2, and the Public Health Service for 1. The Department of Labor designates representatives of labor on all sectional committees dealing with safety codes, and is publishing approved safety codes as Government documents. The State governments are taking a leading part in the entire safety-code program through the Association of Governmental Labor Officials and the International Association of Industrial Accident Boards and Commissions. State highway and traffic commissions are participating in A. E. S. C. activities through the American Association of State Highway Officials, the regional conferences of motor-traffic administrators, and the railway and utility commissions. Prior to the official promulgation of specifications for engineering materials formulated by the Federal Specifications Board these specifications are being circulated by the A. E. S. C. to determine their acceptability to industry. In order to avoid overlap or duplication in undertakings, the A. E. S. C. and the division of simplified practice are so conducting their programs that problems in the nature of simplification that can be handled by a consideration of production data alone are referred to the Division of Simplified Practice, whereas problems in the nature of standardization which involve technical considerations are referred to the A. E. S. C.

Foreign Cooperation.—The American Engineering Standards Committee is cooperating actively with all of the national standardiz-

ing bodies in other countries, of which there are now 19, as follows: Australia, Austria, Belgium, Canada, Czechoslovakia, Denmark, Finland, France, Germany, Great Britain, Holland, Hungary, Italy, Japan, Norway, Poland, Russia, Sweden, and Switzerland. These bodies keep in active touch with each other by correspondence, exchanging information in regard to new projects, draft standards, and general tendencies in the national work in the respective countries. Each national standardizing body acts as a sales agent for the approved standards of the other bodies. A preliminary basis has recently been laid for a general international organization for industrial standardization, at a conference in New York under the auspices of the A. E. S. C., at which the national standardizing bodies of 18 countries were officially represented. The details of this organization and the nature and extent of American participation have not yet been determined. It is expected that decisions will be reached in this and other matters at a conference to take place in Italy in September, 1927.

Information Service.—Complete sets of standards approved by the foreign national standardizing bodies and a good majority of the standards issued by the important organizations in this country are kept on file at the headquarters of the A. E. S. C., which maintains an information service for the benefit of committees working under its auspices, of members and sustaining members, and of American industry generally. The A. E. S. C. acts as a central distributing agent for the standards and specifications of the national technical societies and trade associations listed in the National Directory of Commodity Specifications. It issues monthly a mimeographed bulletin for the benefit of sustaining members, giving information concerning activities in foreign standardization work and reviewing proposed and approved American standards and other developments in the American standardization field.

Current Activities.—Under the auspices of the A. E. S. C. 91 standardization projects have been carried forward to completion and 150 additional projects are in various stages of progress. In the accompanying table is shown the distribution of these projects among the industrial groups.

Industrial groups	Projects	
	Total	Approved
Civil engineering and building trades	39	18
Mechanical engineering	66	12
Electrical engineering	37	10
Automotive	4	2
Transportation	11	9
Naval architecture and marine engineering	1	
Ferrous metallurgy	10	7
Nonferrous metallurgy	14	10
Chemical	13	10
Textile	3	1
Mining	20	3
Wood	5	3
Pulp and paper	2	1
Miscellaneous	16	5
	241	91

Participating in the work through officially accredited representative are 365 national organizations, technical, industrial, and governmental. Of these over 170 are trade associations. Subscribing directly to its support are 267 organizations and firms interested in its work and listed as sustaining members.

Member Bodies.—The main committee is composed of official representatives of member bodies, of which there are now 24, comprising 35 separate national organizations, including 9 national engineering societies, 19 national industrial associations, and 7 departments of the Federal Government. These are as follows:

American Electric Railway Association.

American Institute of Architects.

American Institute of Electrical Engineers.

American Institute of Mining and Metallurgical Engineers.

American Mining Congress.

American Railway Association (engineering division).

American Society of Civil Engineers.

American Society of Mechanical Engineers.

American Society for Testing Materials.

Association of American Steel Manufacturers.

Electric Light and Power Group (Association of Edison Illuminating Companies, National Electric Light Association).

Fire Protection Group (Associated Factory Mutual Fire Insurance Companies, National Board of Fire Underwriters, National Fire Protection Association, Underwriters' Laboratories).

Gas Group (American Gas Association, Compressed Gas Manufacturers' Association, International Acetylene Association).

National Electrical Manufacturers Association.

Safety Group (National Bureau of Casualty and Surety Underwriters, National Safety Council).

Society of Automotive Engineers.

Telephone Group (Bell Telephone System, United States Independent Telephone Association).

United States Departments of Agriculture, Commerce, Interior, Labor, Navy, War, and The Panama Canal.

Additional Sponsor Organizations.—Although not member bodies of the A. E. S. C., the following organizations are serving as sponsors for standardization projects under A. E. S. C. auspices: American Association for the Advancement of Science; American Association of State Highway Officials; American Automobile Association; American Drop Forging Institute; American Foundrymen's Association; American Gear Manufacturers Association; American Society of Heating and Ventilating Engineers; American Society of Refrigerating Engineers; American Society for Municipal Improvements; American Water Works Association; American Zinc Institute; Association of Electragists, International; Association of Governmental Labor Officials of the United States and Canada; Association of Railway Electrical Engineers; Electrical Safety Conference; Grinding

Wheel Manufacturers Association of the United States and Canada; Heating and Piping Contractors National Association; Illuminating Engineering Society; Institute of Radio Engineers; International Association of Industrial Accident Boards and Commissions; Laundryowners National Association; Manufacturers Standardization Society of the Valve and Fittings Industry; Mine Inspectors Institute of America; National Association of Amusement Parks; National Association of Mutual Casualty Companies; National Committee on Metals Utilization; National Founders Association; National Machine Tool Builders Association; New England Water Works Association; Plumbago Crucible Association; Society of Naval Architects and Marine Engineers; Society for the Promotion of Engineering Education; United States Bureau of Mines; United States Bureau of Public Roads; National Bureau of Standards; United States Government Federal Specifications Board; United States Forest Service; United States Geological Survey; United States Bureau of the Public Health Service.

AMERICAN MARINE STANDARDS COMMITTEE

At the marine exposition held in November, 1922, in New York under the auspices of the American Marine Association, there was appointed a committee generally representative of the marine industry which, with the cooperation of the Department of Commerce and the United States Shipping Board, developed the plan of operation for the American Marine Standards Committee, which was organized to encourage simplification of practice in the shipbuilding, ship operating, and allied industries by promoting, developing, and promulgating, in cooperation with all concerned, such standards of design and practice as are deemed in the interest of good economy. The committee maintains headquarters in the division of simplified practice, United States Department of Commerce, Washington, D. C. A. V. Bouillon is the secretary.

An executive board, elected from and by the membership, appoints and controls the administrative officers and technical committees, directs the general policies, and defines the technical working program. The administrative details devolve upon the chairman and the secretary, the latter being in direct charge of all activities. The technical work is under general control of a technical committee in each of the divisions. These committees appoint or approve subject committees for study and development of projects put on the active technical program. The secretary is a member ex officio of every committee, and it is part of his duties to harmonize the work.

Activities of the committee embrace standards relating to the design, construction, and manufacture of hulls, machinery, equipment, and fittings for ships and port facilities, also supplies for their maintenance and operation. There are five technical divisions, the first three of which have so far been made active, viz, (1) hull details;

(2) engineering (ship machinery) details; (3) ship-operation details and supplies; (4) port facilities; (5) manufacture and construction.

When a project (one item or a related group of items) is placed on the active program the secretary proceeds, in consultation with the technical committee concerned, to form a committee of qualified persons to study the subject and make recommendations in regard thereto. Simultaneously he gathers available data on current practice for information of the prospective committee. Upon enrollment of the subject committee and confirmation thereof by the technical committee the work is proceeded with by meetings, correspondence, or individal conferences to the point where recommendations are made by the subject committee, which are then submitted to the technical committee or committees concerned therein. When a proposed standard is tentatively approved by the technical committee it is submitted to the constituent members and others deemed to be interested therein. If the resultant criticism or suggestions so warrant the project is returned to the committees concerned for further consideration, and ultimately it is submitted to the executive board with a summary of the proceedings and final recommendations of the committees. The action of the board fixes the status of the completed projects either as (*a*) Suggested American marine practice, (*b*) tentative American marine standard, and (*c*) American marine standard. The action of the board is communicated to the membership and copies of approved standards are distributed to all concerned.

Under present arrangements the administration of the organization is carried on as a distinct unit of the division of simplified practice, Department of Commerce.

The membership, which now comprises over 300 associate member bodies and is increasing, is composed of shipbuilders, ship operators, naval architects, marine engineers, manufacturers, and, generally, commercial, educational, and Government interests related to the marine industry, among which are the following:

American Bureau of Shipping; American Marine Association; American Society of Marine Designers; American Society of Naval Engineers; American Society of Refrigerating Engineers; American Steamship Owners Association; American Vitrified China Manufacturers Association; Association of American Steel Manufacturers; Association of Marine Underwriters of the United States; Atlantic Coast Shipbuilders' Association; Maritime Association of the Port of New York; National Association of Cotton Manufacturers; National Merchant Marine Association; Neptune Association; Shipbuilders' Club of the Pacific Northwest; Society of Automotive Engineers (Inc.); Society of Naval Architects and Marine Engineers; Underwriters' Laboratories; Underwriters (the board of) of New York (incorporated with the National Board of Marine Underwriters); United States Salvage Association (Inc.); United States

Shipping Board, Emergency Fleet Corporation; Commerce Department, Bureau of Lighthouses; Navy Department, Bureau of Construction and Repair; Navy Department, Bureau of Engineering; The Panama Canal; United States Coast Guard; United States Public Health Service; United States Steamboat Inspection Service; War Department, Office of the Quartermaster General; and Office of the Chief of Engineers.

The organization at present comprises an executive board, 3 administrative committees, 2 active special committees, 3 technical committees, and 41 subject committees. Participating in the technical activities of these committees are 278 individuals. Thirty-two standards have been approved for promulgation, and 3 standards of other bodies have been officially indorsed.

Coordination with progress in related activities is provided for through the agency of representatives appointed as advisory to the executive board by the following organizations: American Institute of Electrical Engineers, American Society of Civil Engineers, American Society of Mechanical Engineers, American Society for Testing Materials, National Fire Protection Association, and the National Bureau of Standards. The committee is officially represented on 20 sectional and special committees functioning under the rules of procedure of the American Engineering Standards Committee.

AMERICAN SOCIETY FOR TESTING MATERIALS

Organized for the purpose of promoting the knowledge of materials of engineering and the standardization of specifications and methods of testing, standardization is a most important function of the society. Standing committees of the society, of which there are now 45 are appointed by the executive committee either upon recommendation of the society at an annual meeting or on the executive committee's own initiative. The appointment of such committee is preceded by a careful study of the field of work proposed for the new committee and conferences with industries producing and using the materials which are to be studied. Assurance is sought of adequate support by these groups, of research and investigation necessary to promote knowledge of the materials and to develop standards, before committees are appointed. Nearly all the society's committees deal with subjects having a commercial bearing, and these are organized so that there is either an equal numeric balance between representatives of producing and nonproducing interests or the nonproducing interests are in the majority. The committees are authorized to conduct investigations and to prepare standards for materials (including specifications, methods of test, definitions, and nomenclature). The results of their investigations and their recommendations as to standards are presented to the society each year for action, and final authority rests with the society. Practically all of the society's committees are actively engaged in the work of

standardization and preparation of specifications. The headquarters of the society are at 1315 Spruce Street, Philadelphia, Pa. C. L. Warwick is the secretary-treasurer.

Standards of the society are published triennially in a book of standards, and supplements to this are issued in intervening years. Tentative standards, which are offered for publication to secure criticism and comment, are published in the annual proceedings and collected each year in a book of tentative standards.

Among the current activities of the society the development of the following standards may be cited as of outstanding importance: For metals for high-temperature service; zinc-coated and other metallic-coated products for increased resistance to corrosion; magnetic testing and analysis of metals; ferro-alloys; metallic materials for electric heating; cement, concrete, and concrete products; ceramic products; preservative coatings; petroleum products; road and paving materials; waterproofing and roofing materials; electrical insulating materials; textile materials; slate; naval stores.

In the following table are shown the number of standards and tentative standards adopted in the year 1926 and the total number adopted to date, the standards being classified in accordance with the five main heads under which the society's standardization activities are conducted:

	Adopted in 1926			Total adopted to date		
	Standards	Revisions to standards	Tentative standards	Standards	Revisions to standards	Tentative standards
A. Ferrous metals	3	0	14	76	27	33
B. Nonferrous metals	3	0	12	45	14	20
C. Cement, lime, gypsum, and clay products	4	3	11	37	10	22
D. Miscellaneous materials	12	0	51	108	12	141
E. Miscellaneous subjects	1	0	6	6	4	11
Total	23	3	94	272	67	227

As one of the five technical societies which united in the founding of the American Engineering Standards Committee, the A. S. T. M. has been especially active in the work of the A. E. S. C., to which it has submitted many of its standards for approval. It is sponsor or joint sponsor for 54 standardization projects or sectional committees functioning under A. E. S. C. procedure, as follows:

	Projects
A. Ferrous metals	11
B. Nonferrous metals	18
C. Cement, lime, gypsum, and clay products	6
D. Miscellaneous materials	19

A. Specifications for welded and seamless steel pipe; specifications for welded wrought-iron pipe; specifications for carbon steel and alloy steel forgings; specifications for cold-drawn Bessemer steel screw

stock; specifications for cold-drawn open-hearth steel automatic screw stock; specifications for zinc coating of iron and steel; specifications for carbon steel and alloy steel blooms, billets, and slabs for forgings; specifications for refined wrought-iron bars; specifications for wrought-iron plates; specifications for stay bolt, engine bolt, and extra refined wrought-iron bars; numbering of steels (with the Society of Automotive Engineers); specifications for cast-iron pipe and special castings (with three other organizations).

B. Insulated wires and cables for other than telephone and telegraph use (with nine other organizations); zinc and zinc ores (with the American Zinc Institute); specifications for electrolytic copper wire bars, cakes, slabs, billets, ingots, and ingot bars; specifications for soft or annealed copper wire; specifications for brass forging rod; free-cutting brass rod for use in screw machines; specifications for brass (naval) rods for structural purposes; specifications for brass ingot metal for sand castings; specifications for solder metal; specification for high sheet brass; specifications for hard-drawn copper wire; specifications for medium hard-drawn copper wire; tinned soft or annealed copper wire for rubber insulation; methods of chemical analysis of manganese bronze; methods of chemical analysis of gun metal; chemical analysis of alloys of lead, tin, antimony, and copper; methods of battery assay of copper; specifications for Lake copper wire bars, cakes, slabs, billets, ingots, and ingot bars.

C. Specifications and tests for Portland cement; specifications and fire tests of materials and construction (with the National Bureau of Standards and fire protection group); specifications for draintile (with the United States Department of Agriculture); method of test for unit weight of aggregate for concrete; method of test for voids in fine aggregate for concrete; method of test for organic impurities in sands for concrete.

D. Test for toughness of rock; method for distillation of bituminous materials suitable for road treatment; method of test for penetration of bituminous materials (with three other organizations); sampling of stone, slag, gravel, sand, and stone block; test for apparent specific gravity of coarse aggregates; cement grout filler for brick and stone pavements; methods of testing and specifications for road materials; tests for specific gravity of sand, stone, and slag screenings; methods of laboratory sampling and analysis of coke; specifications for linseed oil (with the Federal Specifications Board); method of test for flash point of volatile flammable liquids; methods of routine analysis of white pigments; methods of routine analysis of yellow, orange, red, and brown pigments containing iron and manganese; methods of routine analysis of dry red lead; methods of testing cotton yarns and fabrics; specifications for rubber-lined fire hose (with the fire protection group); methods of testing wood (with the United States Forest

Service); method of sampling coal; methods of testing petroleum products and lubricants; specifications for block for granite-block pavements.

The American Society for Testing Materials is officially represented on 15 additional sectional committees functioning under A. E. S. C. procedure.

The A. S. T. M. is represented officially on the following joint committees: Investigation of the effect of phosphorus and sulphur in steel (with 10 other organizations); standard specifications for concrete and reinforced concrete (with four other organizations); concrete culvert pipe (with 6 other organizations); girder rail specifications (with the American Electric Railway Engineering Association); trolley wire specifications (with the American Electric Railway Engineering Association); definitions of terms relating to heat treatment (with the American Society for Steel Treating and the Society of Automotive Engineers); methods of test for petroleum oils for wood preservation (with the American Wood Preservers' Association); effect of temperature on the properties of metals (with the American Society of Mechanical Engineers); molding sand research; pattern equipment standardization; boiler feed water problems (with four other organizations).

The A. S. T. M. maintains two research associates at the National Bureau of Standards doing research work on the correlation of data on cement tests.

CENTRAL COMMITTEE ON LUMBER STANDARDS

This organization, made up of 11 representatives of lumber manufacturers, wholesalers, retailers, and consumers, was created to act as an executive steering organization in drafting recommendations for the simplification of sizes, nomenclature, grades, and trade practices in the softwood and hardwood industries in cooperation with the United States Department of Commerce and the United States Department of Agriculture. Its headquarters are in the Transportation Building, Washington, D. C. Harry G. Uhl is the executive secretary.

Members of the central committee are appointed by their representative groups. The committee has no judicial authority in the industry, but serves as a central clearing house between the industry and the Government in encouraging the putting into practice of those recommendations which have been indorsed by general conferences representing all branches of the trade and the public.

The central committee is served by two advisory committees, namely, the consulting committee on lumber standards and the hardwood consulting committee, composed of about 30 members each, who are official representatives of the following organizations: The

American Institute of Architects, American Railway Association, American Society of Civil Engineers, American Society for Testing Materials, Associated General Contractors of America, Association of Wood Using Industries, National American Wholesale Lumber Association, National Association of Box Manufacturers, National Association of Purchasing Agents, National Lumber Manufacturers' Association and regional lumber manufacturers' associations, National Retail Lumber Dealers' Association, Northeastern Retail Lumbermen's Association, Northwestern Lumbermen's Association, Society of Automotive Engineers (Inc.), Southwestern Lumbermen's Association, and the Wholesale Sash and Door Association.

To the advisory committees are submitted all matters to be passed upon for recommendation by the central committee, and in these bodies all of the scientific research and study are conducted with the aid of various governmental agencies. Like the central committee, members of the advisory committees are selected by the groups they represent. Recommendations are made by the consulting committees to the central committee, and if members of the central committee approve the recommendations they are then docketed for consideration by a general conference of all interested lumber manufacturers, wholesalers, retailers, and consumers, held annually at the Department of Commerce, Washington, D. C. Recommendations approved by the general conference are recognized as American lumber standards and published by the division of simplified practice for the benefit of the trade and the public. The recommendations include lumber classifications, nomemclature of commercial softwoods, shipping practices, basic provisions for structural material, softwood factory and shop lumber, lumber inspection provisions, and American standard moldings. Simplification of sizes, nomenclature, grades, and trade practices has been accomplished in the softwood industry.

In 1926 the central committee completed work on standards for softwood factory and shop lumber, the determination of single-standard thicknesses for finished lumber based on the thicknesses of standard unfinished lumber with allowance for shrinkage and planing, and the establishment of marketing practice covering short lengths of lumber.

The central committee is now engaged in the following projects: Uniform patterns for worked lumber, shipping weights and moisture content, structural timbers, supply and demand survey of American standard lumber, and hardwood standardization.

IX. STANDARDIZING ACTIVITIES OF TECHNICAL SOCIETIES AND TRADE ASSOCIATIONS

A large percentage of the national technical societies, trade associations, and similar organizations make standardization one of the important activities in their services to their members.

Outlines of the standardization activities of these organizations are given below.

ALPHABETICAL LIST OF SOCIETIES AND ASSOCIATIONS

American Association for the Advancement of Science, Burton E. Livingston, permanent secretary, Smithsonian Institution Building, Washington, D. C. The only standardization activity of the association is in connection with the survey of scientific and engineering symbols and abbreviations. The association is joint sponsor, with four other organizations, for the sectional committee handling this project, which is functioning under the rules of procedure of the American Engineering Standards Committee.

American Association of Engineers, M. E. McIver, acting secretary, 63 East Adams Street, Chicago, Ill. Although the work of this association is confined to problems of economic and social welfare of engineers and to the encouragement and development of efficiency in engineering work and the proper usage of the term "engineer," it has organized a committee to study standard proposals and contracts for engineers' services and other work of like character.

American Association of State Highway Officials, W. C. Markham, secretary, 638 Munsey Building, Washington, D. C. This association has been especially active in the promotion of the use of standardized plans and specifications for highway construction throughout the country. It has adopted a standard form for road plans and secured its use in practically all of the States. It has issued a standard outline and arrangement for highway and bridge specifications which is being used as the basis for general highway specifications by most of the States. It has been active in the promotion of standardized specifications for materials used in constructing highways and for the design and construction of steel, concrete, and timber bridges. Standard methods of sampling and testing highway materials have been adopted by the association and these specifications, together with all others so far issued through the association, have been approved by the United States Secretary of Agriculture for use in connection with Federal-aid road and bridge construction. To its influence can largely be attributed the present uniformity throughout

the country of road signs and danger signals and the elimination of misleading "stop" signs. The association is officially represented on the joint concrete culvert pipe committee (with six other organizations). It is joint sponsor for two sectional committees functioning under the rules of procedure of the American Engineering Standards Committee, as follows: Method of test for penetration of bituminous materials (with three other organizations), and colors for traffic signals (with the National Bureau of Standards and the National Safety Council). The association is officially represented on 11 additional sectional committees functioning under A. E. S. C. procedure.

American Association of Textile Chemists and Colorists, Walter E. Hadley, secretary, 5 Mountain Avenue, Maplewood, N. J. This organization concerns itself with research work on chemical processes and application of dyes and chemicals to materials manufactured in the textile industry. Its standardization activities are carried on by committees appointed by the president whose functions are to study, analyze, and prepare reports on methods of tests for adoption by the association. Methods of fastness of dyed wool and silk to fulling, scouring, and washing, as well as dyed and printed cotton to scouring, washing, soaping, laundering, and chlorine treatment have been revised. Work is also going forward on methods of fastness to perspiration and fastness to light, fastness tests to dry and wet heat, fastness to acids and alkalies, carbonizing, and sea water. The research committee is engaged in the formulation of standard methods of dye testing. This work is being performed in various laboratories, representing consumers, textile manufacturers, dyestuff manufacturers, and general testing laboratories. The results of these tests will be embodied in a report to be presented at the association's annual convention. Progress has been made in the endeavor to establish international standard methods of dye testing, and a joint committee of European and American members is being organized to study carefully the possibilities and advisability of such an undertaking. In this connection the British Society of Dyers and Colourists has expressed its desire to cooperate. The association maintains contact with the National Bureau of Standards in research work on chemicals applied to textiles.

American Association of Woolen and Worsted Manufacturers, J. J. Nevins, secretary, 45 East Seventeenth Street, New York, N. Y. All standardization work of this organization is conducted through a joint committee on research and standardization composed of representatives of this association, the National Association of Wool Manufacturers, and the National Association of Woolen and Worsted Spinners. Recommendations of the association are submitted to the joint committee before final adoption as standards.

American Automobile Association, Ernest N. Smith, general manager, national headquarters, Washington, D. C. Being interested particularly in the operation rather than the manufacture of automobiles, this association has taken no part officially in the formulation of dimensional standards. However, it is serving as joint sponsor, with the National Bureau of Standards, for the sectional committee on safety code for automobile brakes and brake testing and is officially represented on the sectional committee on colors for traffic signals, functioning under A. E. S. C. procedure.

American Bureau of Welding, William Spraragen, secretary, division of engineering, National Research Council, 33 West Thirty-ninth Street, New York. This bureau acts as an advisory board on welding of the American Welding Society and of the division of engineering and industrial research of the National Research Council. The bureau consists of 12 members appointed by the board of directors of the American Welding Society; 2 representatives from each section of this society, not over 12 members at large appointed by the executive committee of the society, and 1 representative of each of the following interested societies, associations, and Government departments: American Bureau of Shipping, American Electrochemical Society, American Electric Railway Association, American Engineering Standards Committee, American Institute of Electrical Engineers, American Institute of Mining Engineers, American Institute of Steel Construction, American Physical Society, American Society of Civil Engineers, American Society of Mechanical Engineers, American Society of Refrigerating Engineers, American Society for Testing Materials, Navy Department, National Bureau of Standards, Bureau Veritas, Engineering Foundation, Federal Board of Vocational Education, Lloyd's Register of Shipping, National Research Council, New York Academy of Sciences, Society of Automotive Engineers. Each research committee of the bureau is created by the appointment of a chairman who appoints the individual members of his committee, subject to the approval of the executive committee of the bureau, the American Welding Society, and the National Research Council. Committees have been organized to deal with the following subjects: Electric arc welding, gas welding, pressure vessels, welding structural steel, welded rail joints, and welding wire specifications. The committee on welded rail joints maintains a research associate at the National Bureau of Standards doing research work on welded rail joints. Standard specifications formulated by the committees and approved by the bureau through its executive committee are issued to the welding industry as publications of the American Welding Society.

American Ceramic Society, Ross C. Purdy, secretary, 2525 North High Street, Columbus, Ohio. The actual work of preparing pro-

posed standards and specifications for the society is carried on by its several divisional standardization committees. Standards approved by the divisional committees are passed upon by the society's committee on standards which has been organized to avoid the adoption within the society of conflicting standards and to be the medium through which the divisional committees present their adopted standards to the society for recognition as the society's standards. In formulating standards the society has cooperated with the American Society for Testing Materials and the National Bureau of Standards, full advantage being taken of the specifications of the former and the research work of the latter. It has taken an active part in the industrial waste elimination program of the Department of Commerce. In cooperation with the American Hotel Association it inaugurated the movement which resulted in the simplified practice recommendation relating to hotel chinaware. It has also taken an active part in the work of the committee for simplification of paving bricks.

American Chemical Society, Charles L. Parsons, secretary, Mills Building, Washington, D. C. The committee on guaranteed reagents of the society published, in 1925, specifications for 14 analytical reagents, and in 1926 published 23 specifications. The work is still going on. In 1920 and 1921 the committee suggested certain metric unit weights for packages of reagent chemicals. The society committee on the metric system has advocated the use of these unit weights, and they have been adopted by several manufacturers of fine chemicals. The committee on standard apparatus published in 1921 and 1922 reports on elimination of sizes and shapes of chemical laboratory apparatus. These reports were prepared in cooperation with the committee on standardization of the Association of Scientific Apparatus Makers of the United States of America, and have been followed almost completely in the preparation of some recent catalogues of dealers in chemical apparatus. The committee has made additional recommendations on elimination and has done work on the standardization of dimensions of some types of laboratory apparatus. The society committees on revision of methods of coal sampling and analysis, standard methods for the examination of water and sewage to cooperate with committee of American Public Health Association, standardization of biological stains, and standardized methods for vitamin research cooperate with committees of other organizations on the subjects designated, and the supervisory committee on standard methods of analysis is responsible for the uniformity of standards for methods of analysis proposed by all committees of the society.

American Concrete Institute, Harvey Whipple, secretary, 2970 West Grand Boulevard, Detroit, Mich. Its by-laws provide for

the creation by the board of direction of special committees for the purpose of preparing recommended practice and standards concerning the proper use of cement. Under these by-laws the board of direction creates the committee and appoints the chairman. Additional committee members are appointed by the president in consultation with the chairman. Proposed new or revised standard specifications, standard practice, and standard definitions, when approved by a majority voting in the committee in which they originate, are submitted to the secretary of the institute 60 days prior to the opening of the annual convention at which they are to be presented. They are printed as proposed tentative standards and mailed to the full membership of the institute 30 days prior to the opening of the convention. As there amended and approved, they are published as tentative standards. At a subsequent annual convention they may again be offered unamended by their originating committee as proposed standards, and if again approved in convention are submitted to letter ballot of the institute membership, canvassed within 90 days thereafter. Such proposed standards are considered adopted unless at least 10 per cent of those voting vote in the negative. The institute has issued 14 standard specifications, 2 tentative specifications, and 3 recommended practices. Of these the following were issued in 1926: Standard methods for the measurement of concrete work and standard specifications and building regulations for concrete staves. The institute is officially represented on the following joint committees: Standard specifications for concrete and reinforced concrete (with 4 other organizations); concrete culvert pipe (with 6 other organizations); cement (with several other organizations); reinforcing spirals (with several other organizations). It has official representation on 8 sectional committees functioning under the procedure of the American Engineering Standards Committee.

American Concrete Pipe Association, M. W. Loving, secretary, 33 West Grand Avenue, Chicago, Ill. Although the association has not officially established any standards or adopted any specifications it cooperates to the fullest extent with the American Concrete Institute, the American Society for Municipal Improvements, and the American Society for Testing Materials, and with other organizations represented on the joint concrete culvert pipe committee in the preparation of specifications for concrete pipe, including drain tile, cement, concrete sewer pipe, reinforced concrete sewer pipe, and reinforced concrete culvert pipe.

American Corn Millers Federation, Reynier Van Evera, secretary, 6 West Tenth Street, Kansas City, Mo. Under authority conferred upon him at a meeting of the federation, the president has appointed a standardizing committee to cooperate with the United States

Department of Agriculture in establishing standards and specifications for cream meal. The federation has adopted a symbol to be licensed by the federation to all millers who will agree to conform to the specifications.

American Cotton Manufacturers' Association, William McLaurine, 703 Commercial Bank Building, Charlotte, N. C. (See National Council of American Cotton Manufacturers.)

American Drop Forging Institute, with headquarters at 1001 Union Bank Building, Pittsburgh, Pa. Among the stated objects of this organization is the standardization, so far as practicable, of the drop-forging industry, including designs, specifications, and contract forms. It has formulated recommendations concerning good practice in manufacturing processes and quotation forms. It is serving as joint sponsor with the National Safety Council for the sectional committee on safety code for forging and hot-metal stamping functioning under A. E. S. C. procedure.

American Electric Railway Association, J. W. Welsh, executive secretary, 292 Madison Avenue, New York, N. Y. Affiliated with the parent association are certain dependent associations, each interested in certain special phases of the electric railway industry. Of these the American Electric Railway Engineering Association is the one which deals with standards and specifications which, after adoption, are published in the association's Engineering Manual. A committee on subjects is appointed annually by the president to consider and suggest topics for the work of the engineering association. The executive committee approves those subjects to be studied by the standing committees, including subjects leading to the possible adoption of standards or recommendations. Proposed standards and recommendations are submitted first for approval or disapproval to the committee on standards, which also is appointed by the president. Following action by the committee on standards such proposed standards and recommendations are considered at the association's annual convention and voted upon by the assembled delegates. The Engineering Manual, originally published in loose-leaf form and revised annually, is now published every third year as a bound book. Supplements are issued ad interim between editions of the manual, to take care of revisions and new specifications. Much work during the past year has been done by the committees in preparation for the current editions of the Engineering Manual. The association is a member of the American Engineering Standards Committee and, through it, takes active part in the consideration of all proposed standardization and code work affecting the industry, cooperating chiefly in the preparation of standards with the American Institute of Electrical Engineers, the American Railway Engineering Association, the American Society for Municipal Improvements, the

American Society for Testing Materials, the American Society of Mechanical Engineers, the American Wood Preservers' Association, and other organizations. The association is sponsor or joint sponsor for 13 sectional committees functioning under the rules of procedure of the American Engineering Standards Committee as follows: Insulated wires and cables for other than telephone and telegraph use (with nine other organizations); specifications for tubular steel poles; recommended specifications for 600-volt direct-current overhead trolley construction; recommended designs for joint plates for 7-inch and 9-inch girder grooved and girder guard rails; recommended designs for 7-inch, 80-pound, 91-pound, and 102-pound plain girder rail for use in paved streets; specifications for use in the manufacture of materials for special track work. The association is officially represented on 35 additional sectional committees functioning under the A. E. S. C.

American Electrochemical Society, Colin G. Fink, secretary, Columbia University, New York, N. Y. Although standardization is not a major activity of the society it has organized a radio battery committee, which has formulated standard tests for dry cells used in radio receiving sets, in cooperation with the National Bureau of Standards and the Associated Manufacturers of Electrical Supplies.

American Face Brick Association, R. D. T. Hollowell, secretary, 130 North Wells Street, Chicago, Ill. The standardization activities of the association are confined to those relating to dimensions. A committee on standard sizes has been appointed by the president to determine approximate dimensions for face brick which will be most economical and desirable from the point of view of both the public and the producers, and to embody the dimensions in the form of a recommendation to the industry at large. In 1926 the association reaffirmed the resolution adopted at the conference held in 1923 relating to face-brick sizes, set forth in Department of Commerce Simplified Practice Recommendation No. 7. The association maintains a research associate at the National Bureau of Standards, doing research work on the prevention of stains on brick structures.

American Forestry Association, O. M. Butler, executive secretary, 1523 L Street, NW., Washington, D. C. This association has never adopted any specifications, but has cooperated in the standardization movement by official representation on the sectional committees on safety code for logging and sawmill machinery, and specifications for wood poles, functioning under A. E. S. C. procedure.

American Foundrymen's Association, C. E. Hoyt, secretary, 140 South Dearborn Street, Chicago, Ill. An effective method of cooperation with the American Society for Testing Materials in the establishment of standards for the foundry industry has been placed

into operation. The association is represented on all A. S. T. M. committees dealing with specifications of interest to its members. Specifications prepared by these committees are submitted to the members of the association for consideration as tentative standards and they are adopted by the association after being adopted as standard by the A. S. T. M. The association is sponsoring the formulation of standard practices and recommended practices for use in connection with pattern equipment. This work is being done in connection with the committee upon which eight interested national bodies are represented. It is sponsoring the joint committee on molding sand research which is standardizing methods of testing and grading foundry sands. This association is also joint sponsor with the American Ceramic Society of the joint committee on foundry refractories (with 10 other national organizations), whose endeavor is to standardize tests for foundry refractories and to simplify the number of shapes of refractories for foundry furnaces. It is represented on the joint committee on the investigation of the effect of phosphorus and sulphur in steel (with 10 other organizations). The association is joint sponsor for two sectional committees functioning under the rules of procedure of the American Engineering Standards Committee, as follows: Safety code for the protection of industrial workers in foundries (with the National Founders' Association); outside dimensions of plumbago crucibles for non-tilting furnaces in nonferrous foundry practice (with the Plumbago Crucible Association). It is officially represented on five additional sectional committees functioning under A. E. S. C. procedure.

American Gas Association, Alexander Forward, managing director, 342 Madison Avenue, New York, N. Y. All committee organization is subject to the approval of the executive board of the association, appointments to the committees being made by the president upon the basis of the technical qualifications of the individuals and the need for representation of different interests. The activities of each of the seven sections of the association as well as those of the appliance-testing laboratory are directed by a managing committee appointed on a representative basis. In the testing laboratory at Cleveland domestic gas-burning appliances are tested and certified as to economy in accordance with specifications covering performance, structural details, and design prepared by committees composed of representatives of the association and a number of other national bodies cooperating in the undertaking. The work of the laboratory committees is submitted to the executive board in the form of recommendations of the managing committee of the laboratory. The standards of the association are adopted by action of a general session of the association at an annual meeting held not less than one year after approval as tentative standard by the executive board

and following circulation of the tentative standard to the membership for study and criticism. Committees have been organized to deal with such subjects as space heaters, gas ranges, water heaters, central house-heating appliances, carbonization, gas chemistry, distribution, and refractories. The gas association is joint sponsor for three sectional committees functioning under the rules of procedure of the American Engineering Standards Committee, as follows: Specifications for cast-iron pipe and special castings (with three other organizations); pipe thread (with the American Society of Mechanical Engineers); and gas safety code (with the National Bureau of Standards). The association is represented on nine additional sectional committees functioning under A. E. S. C. procedure. It maintains a research associate at the National Bureau of Standards doing research work on the methods of testing gas appliances to determine their safety.

American Gear Manufacturers' Association, T. W. Owens, secretary, 2443 Prospect Avenue, Cleveland, Ohio. Standardization is one of the stated purposes of this organization which devotes considerable time to the dimensional standardization of gears. It is serving as joint sponsor for two sectional committees, as follows: Gears (with the American Society of Mechanical Engineers); transmission chains and sprockets (with the American Society of Mechanical Engineers and the Society of Automotive Engineers), and is officially represented on the sectional committee on shafting functioning under A. E. S. C. procedure.

American Hardware Manufacturers Association, Charles F. Rockwell, secretary, 342 Madison Avenue, New York, N. Y. Such standardization work as is conducted by this association is carried forward under the auspices of the American Engineering Standards Committee. In cooperation with the National Hardware Association of the United States it has been instrumental in reducing the number of commercial sizes for steel sheets under the auspices of the division of simplified practice, and it is officially represented on the sectional committee on bolt, nut, and rivet proportions functioning under A. E. S. C. procedure.

American Hospital Association, William H. Walsh, M. D., executive secretary, 18 East Division Street, Chicago, Ill. This association has organized a committee on simplification and standardization of general furnishings, supplies, and equipment, and a committee on dietary service and equipment, the functions of which are indicated by their names. These committees are appointed annually by the president. All studies undertaken by the committee on furnishings and supplies have been conducted in cooperation with the division of simplified practice of the Department of Commerce. The sizes of hospital beds and hospital chinaware have already been

simplified, and the standardized sizes have been widely adopted by the hospitals of the country. A statistical study has been made of hospital linen to establish standard sizes.

American Hotel Association, J. K. Blatchford, secretary, Auditorium Tower, Chicago, Ill. This association, in cooperation with the American Ceramic Society and the American Vitrified China Manufacturers Association, has been instrumental in launching a program of standardization in table chinaware under the auspices of the division of simplified practice, which has resulted in the formulation of simplified practice recommendations relating to hotel, restaurant, dining-car, and hospital tableware. It has issued a list of specifications for soaps and cleaning compounds in which are incorporated the standard methods of test developed by the National Bureau of Standards. The association was officially represented on the advisory board which cooperated with the Department of Commerce in the preparation of the National Directory of Commodity Specifications.

American Institute of Architects, Scientific Research Department, Le Roy E. Kern, technical secretary, 19 West Forty-fourth Street, New York, N. Y. The institute's standardization work is conducted almost entirely in cooperation with other national bodies through its scientific research department. When a request for institute representation on a technical committee or standardizing committee is received the request is referred to the scientific research department which investigates the proposed activities of the committee to determine whether the specialized training of the architect equips him to contribute constructively. This department makes its report to a committee of three architects known as the advisory council which makes a recommendation to the director of the scientific research department which is forwarded to the board of directors of the institute for action. If the recommendation is favorably acted upon by the board, the president of the institute appoints an official representative. Pending the appointment of the official representative the scientific research department acts as institute representative and after the appointment of the official representative acts as alternate. The representative reports to the scientific research department as to whether or not he recommends that the proposed standards be approved by the institute. His recommendation is referred by the scientific research department to the advisory council and to the director and from the director to the board of directors of the institute which gives official approval or disapproval. The institute is represented officially on the National Committee on Metals Utilization, the National Committee on Wood Utilization, and the Building Code Committee of the United States Department of Commerce; on committees of the division of simplified practice of the department

dealing with building materials and appliances; and on committees of the National Fire Protection Association, the American Construction Council, and the Chamber of Commerce of the United States. The institute is joint sponsor for five sectional committees functioning under the rules of procedure of the American Engineering Standards Committee, as follows: Elevators (with the American Institute of Electrical Engineers and the American Society of Mechanical Engineers); safety code for elevators and escalators (with the American Society of Mechanical Engineers and the National Bureau of Standards); safety code for lighting of school buildings (with the Illuminating Engineering Society); symbols for electrical equipment of buildings (with the American Institute of Electrical Engineers and the Association of Electragists, International); safety code for walkway surfaces (with the National Safety Council). The institute is officially represented on 12 additional sectional committees functioning under A. E. S. C. procedure.

American Institute of Baking, H. E. Barnard, president, 1135 Fullerton Avenue, Chicago, Ill. The institute was founded and is conducted by the American Bakers Association for scientific research and education. It has not established standards or specifications for the ingredients used in baked products, or for the technical supplies used in the bakery. It emphasizes the necessity for adherence to the definitions and standards for foods and products promulgated by the United States Secretary of Agriculture as a guide for the officials charged with the enforcement of the food and drugs act, and has published bulletins and literature on these standards for the use of the baking industry. It maintains laboratories for the examination and testing of samples of baking ingredients for the advice and information of bakers and the allied trades, in relation to composition, properties, suitability for use in baking, and compliance with the Federal and State food laws. In 1921 the institute established a registration or certification plan for baking ingredients and technical supplies for the purpose of giving the baker information as to reliable products suitable for use in baking. The plan permits the manufacturer to make application to the institute for the registration or certification of his products. An application for registration is filed by the manufacturer with the institute, which requires information on the purpose for which the product is to be used, its analysis or composition, a complete set of labels, circulars, and other advertising material, and the claims of the manufacturer. A sample is also submitted by the manufacturer for examination, which is subjected to analysis and required tests in order to determine if it complies with the claims of the manufacturer. The manufacturer's sample is checked by duplicate tests on a sample obtained on the market. If the product complies with the claims of the manu-

facturer and is suitable for use in baking, a certificate of registration is issued by the institute. A contract is also made between the institute and the manufacturer governing the use of the "seal of registration." The institute has organized an advisory board for the National Research Council.

American Institute of Electrical Engineers, F. L. Hutchinson, secretary, 33 West Thirty-ninth Street, New York, N. Y. All standardization work of the institute is under the direction of the standards committee, the members of which are appointed by the president. This committee is directly responsible to the board of directors. The committee consists of nine appointed members, the chairman of A. I. E. E. delegations on other standardizing bodies, the chairmen of working committees, and the president of the United States National Committee of the I. E. C. The working committees may include both institute and noninstitute members. The past year has marked the completion of the bulk of the work of revision of the institute standards, a work which has been actively under way for over three years. The revised standards are being published in the form of a number of sections, each section dealing with standards for a specific subject. Twenty-one of over forty proposed sections have been completed, covering the great bulk of material previously incorporated in the single volume of institute standards. The institute is a member body of the American Engineering Standards Committee, and is represented on the electrical advisory committee, the organization of which was recommended to the American Engineering Standards Committee by joint action of the institute and the Electrical Manufacturers Council. The institute is sponsor or joint sponsor for 15 sectional committees functioning under the rules of procedure of the American Engineering Standards Committee, as follows: Elevators (with the American Institute of Architects and the American Society of Mechanical Engineers); rating of electrical machinery; insulated wires and cables for other than telephone and telegraph use (with nine other organizations); symbols for electrical equipment of buildings (with the American Institute of Architects and the Association of Electragists, International); electrical properties of aluminum; radio (with the Institute of Radio Engineers); industrial (electrical) control apparatus (with the Electric Power Club); instrument transformers; alternators, synchronous motors and synchronous machines in general; direct and alternating current fractional horsepower motors; induction motors and induction machines in general; direct-current rotating machines, generators and motors; power-line insulators for voltages exceeding 750 (with the Associated Manufacturers of Electrical Supplies); electrical installations on shipboard; scientific and engineering symbols and abbreviations (with four other organizations). The institute is

represented on 19 additional sectional committees functioning under A. E. S. C. procedure.

American Institute of Mining and Metallurgical Engineers, H. Foster Bain, secretary, 29 West Thirty-ninth Street, New York, N. Y. All standardization work of the institute is conducted through the cooperation of the mining standardization correlating committee. It is officially represented on not only this committee but also on 23 sectional committees functioning under the procedure of the American Engineering Standards Committee. It is serving as sponsor for two of these sectional committees, as follows: Screening of ores; and recommended practice for rock dusting of coal mines.

American Institute of Steel Construction (Inc.), C. F. Abbott, executive director, 285 Madison Avenue, New York, N. Y.; Lee H. Miller, chief engineer, 1052 Leader Building, Cleveland, Ohio. The institute maintains a committee selected from the academic, architectural, and engineering professions, and having no direct financial connection with the steel industry, to prepare and keep up-to-date standard specifications for the design, fabrication, and erection of structural steel for buildings. The specifications issued by the institute are kept in harmony with those of the American Society for Testing Materials. The institute is officially represented on four sectional committees functioning under A. E. S. C. procedure.

American Malleable Castings Association, Robert E. Belt, secretary, Union Trust Building, Cleveland, Ohio. The association has adopted specifications for malleable castings similar to those of the American Society for Testing Materials. It assists members, through laboratory and engineering work, in the production of a product which conforms to the requirements of these specifications. Member plants submit to the association's laboratory test pieces from every heat. Quality certificates are issued to those members whose products meet the requirements of the specifications. These certificates permit the manufacturers to use the trade-mark of the association, and to advertise their products as having been certified to by the association. It publishes regularly the names of members whose products have met the requirements of the specifications.

American Medical Association, Bureau of Investigation, A. J. Cramp, director, 535 North Dearborn Street, Chicago, Ill. Through its bureau of investigation the association has studied the patent medicine question, and has published many reports bearing on this class of products. Information in regard to this branch of the association's activity is published under the title of Nostrums and Quackery, two volumes of which have been issued.

American Medical Association, Council on Pharmacy and Chemistry, W. A. Puckner, secretary, 535 North Dearborn Street, Chicago, Ill. The council has adopted a set of rules by which to judge proprie-

tary medical substances to determine which are and which are not worthy of recognition. Products found to comply with the rules are described in the new and nonofficial remedies department of the Journal of the American Medical Association; annually, a book, New and Nonofficial Remedies, is issued, which contains the description of products which stand accepted on January 1 of the year of issue. The medical profession is informed in regard to the products which are not found acceptable through reports published in the journal of the association; these are collected in The Propaganda for Reform, volumes 1 and 2.

American Mining Congress, J. F. Callbreath, secretary, Munsey Building, Washington, D. C. The standardization activities of the organization are carried on by the division of standardization, of which there are two branches—coal mining and metal mining. Committees of these branches prepare reports on assigned subjects which are presented for discussion at standardization conferences held annually to bring about the adoption of national standards to eliminate waste in the mining industry, simplify mining methods and equipment, and insure safety, efficiency, and conservation. The American Mining Congress is sponsor or joint sponsor for 12 sectional committees functioning under the rules of procedure of the American Engineering Standards Committee, as follows: Safety rules for installing and using electrical equipment in coal mines (with the United States Bureau of Mines); drainage of coal mines; underground transportation in coal mines; ventilation in coal mines (with the United States Bureau of Mines); ventilation in metal mines (with the United States Bureau of Mines); outside coal handling equipment; wire rope for mines; ladders and stairs for mines; safety code for coal mine transportation; firefighting equipment in metal mines (with the National Fire Protection Association); underground transportation in metal mines; mechanical loading underground in metal mines. The congress is represented on seven additional sectional committees functioning under A. E. S. C. procedure.

American Paper and Pulp Association, Hugh P. Baker, executive secretary, 18 East Forty-first Street, New York, N. Y. Standardization activities of this association are conducted through its standardization committee whose function is to study the problems of simplification and standardization in the paper industry and to further standardization among the groups of the industry as represented by the various associations affiliated with the national organization. It has cooperated actively in the recommendations relating to the standardization and simplification of paper issued by the division of simplified practice. The association also has an advisory committee actively cooperating with the National Bureau of Stand-

ards in technical matters relating to the manufacture of pulp and paper.

American Petroleum Institute, Division of Standardization, C. A. Young, director, 1508 Kirby Building, Dallas, Tex. In 1924, the American Petroleum Institute created a division of standardization to cooperate with and assist in correlating the standardization and simplification work already under way. The agencies through which the work is done are (1) the board of directors, (2) the general committee on standardization, (3) the special committees on standardization, and (4) the director of standardization. The board of directors is the governing body of the institute, and as such has authority to direct the work, and to adopt, modify, or reject proposed A. P. I. specifications and standards. It may act through committees of the board, but no specifications nor standards are considered final except when approved by the board. The function of the special committees is to canvass the industry as to the desirability and practicability of standard A. P. I. specifications in relation to the subjects referred to them, and to recommend to the general committee on standardization what action is to be taken in relation to any proposed standards. The general committee on standardization consists of the national chairman of the various special committees. The general committee considers all reports of the various special committees on standardization, and makes final recommendation to the board of directors. The institute grants to manufacturers the right to use the official monogram in the manufacturing of certain standardized equipment upon certifying that the material so marked complies with all of the conditions and specifications contained in the official publication of the institute relating thereto. The institute reserves the right to revoke the license to use its monogram for any reason satisfactory to the board of directors. The institute has inaugurated a very extensive gauge schedule for casing drill pipe and tubing threads and case drilling tool joint threads. A complete set of master gauges for cable drilling tool joints, standardized at the National Bureau of Standards, has been sent to each regional district.

American Pharmaceutical Association, E. F. Kelly, secretary, 10 West Chase Street, Baltimore, Md. An important standardization activity of this association has been the preparation of an authoritative formulary, extra to the United States Pharmacopœia, containing preparations of a nonsecret character which are used by physicians. The committee on national formulary, consisting originally of five members of the association and one representative of each State pharmaceutical association, was appointed in 1886. The work of this committee consisted in trying various formulas for the adopted preparations and in harmonizing the desire of the various sections of the country as to the scope of the formulary. The first

edition of the National Formulary was published in 1888, the second in 1896, the third in 1906, the fourth in 1916, and the fifth in 1926. The committee on national formulary is now a standing committee composed of 15 men from different sections of the country selected by the council of the association as experts in their respective fields and as representing the different branches of pharmacy. In 1909 the association appointed the committee on standards for unofficial drugs and chemicals, whose function was to study and provide suitable definitions and tests for ingredients used in the formulas contained in the National Formulary but not standardized in the United States Pharmacopœia. This committee is now a standing one and assists the committee on national formulary in the revision of the book. Work on the revision of this book is similar to the revision of the United States Pharmacopœia both as to time and manner. The passage of the national food and drugs act on June 30, 1906, made the National Formulary a legal standard and placed it on a par with the United States Pharmacopœia in legal standing.

American Public Health Association, Homer N. Calver, secretary, 370 Seventh Avenue, New York, N. Y. The association has a council on standards to review reports emanating from sections or committees of the association which propose professional or technical standards. Such proposals are published to the membership and when approved by the council on standards are reported to the governing council of the association and when approved by this council become established as the association's standards. In cooperation with the American Water Works Association, the association formulated standard methods of water analysis, the sixth edition of which was issued in 1925. The translation of this document into French and German is now being considered by the health section of the League of Nations. The association has recently revised its standard methods of milk analysis, which will shortly be republished. The standardization program covers standard record forms for health departments, standard forms for the tabulation of vital statistics, and similar matters.

American Railway Association, H. J. Forster, secretary, 30 Vesey Street, New York, N. Y. Activities of the association are conducted under seven divisions, the names of which indicate their scope, as follows. I, operating; II, transportation; III, traffic; IV, engineering; V, mechanical; VI, purchases and stores; VII, freight claims. Four of these divisions are vitally concerned with standards and specifications, namely, operating, which deals with problems of operation; engineering, which deals with the location, construction, and maintenance of railroads; mechanical, which deals with the construction and maintenance of rolling stock; and purchases and stores, which deals with the purchasing, storing, distribution, and selling of mate-

rials and supplies. (See sketches of the operating, mechanical, and purchases and stores divisions and the American Railway Engineering Association.)

American Railway Association, Freight Container Bureau, Edward Dahill, chief engineer, 30 Vesey Street, New York, N. Y. This bureau is functioning to develop and prepare standard specifications for shipping containers for commodities other than explosives and dangerous articles. The work of the engineers of the bureau is carried on in close cooperation with the shippers, national traffic and industrial organizations, Government agencies, and associations of container manufacturers. It is not an inspection agency and does not maintain a corps of inspectors. The basis of the bureau's recommended specifications is economy, efficiency, safety of the shippers' goods, and elimination of the causes of loss and damage to freight shipments.

American Railway Association, Mechanical Division, V. R. Hawthorne, secretary, 431 South Dearborn Street, Chicago, Ill. This division is a consolidation of the former Master Car Builders' Association and the American Railway Master Mechanics Association, and it includes an equipment painting section composed of the former Master Car and Locomotive Painters' Association. Automatic couplers and automatic air brakes were adopted as the universal standards for the railroads of the country through the activities of the Master Car Builders' Association. This association also adopted safety appliances for cars which were afterwards approved by the Interstate Commerce Commission and made compulsory on all railroad cars. In conjunction with the bureau of explosives this association developed a series of specifications for tank cars for transporting inflammable products. It also has developed numerous standards for the different parts of cars and designs for complete box cars of both the single sheathed and the double sheathed types. The American Railway Master Mechanics Association has developed numerous standards for different parts of locomotives. Committees of the equipment painting section are at work on standards for the painting of cars and locomotives. Other committees of the division are working on specifications and tests for materials and standards for various parts of cars and locomotives. After approval by the American Railway Association by letter ballot the specifications are printed in the Manual of Standards and Recommended Practice. The American Railway Association, mechanical division, is represented officially (with 10 other organizations) on the joint committee on the investigation of the effect of phosphorus and sulphur in steel. It is also represented on three sectional committees functioning under A. E. S. C. procedure.

American Railway Association, Operating Division, J. C. Caviston, secretary, 30 Vesey Street, New York, N. Y. The division carries

on the activities of the operating committees of the American Railway Association, and, in addition, includes the activities of the former Association of Railway Telegraph Superintendents, American Association of Local Freight Agents, American Railway Chief Special Agents and Chiefs of Police Association, and the American Railway Chief Surgeon's Association. The division now includes the sections which took the place of the associations mentioned above, as follows: Telegraph and telephone, freight station, protective, medical and surgical, and safety. The operating division proper and its predecessor prepared the standard code of train rules, the standard code of block-signal rules, and the standard code of interlocking rules, which codes are the basis for all such rules on American railways. These codes are kept up to date and all questions pertaining to their interpretation are handled by the division.

American Railway Association, Purchases and Stores Division, W. J. Farrell, secretary, 30 Vesey Street, New York, N. Y. Work of the division is carried on by committees dealing with subjects relating to purchasing and stores department operations such as stores department book of rules, purchasing department rules, classification of material, reclamation of material, material accounting, crossties, handling material, scrap classification, purchasing-office records, lumber, buildings and structures, supply-train operation, standardization and simplification of store stock, budget control of material and supplies requirements, and stationery and printing. Through the cooperative efforts of the railroads represented on the subject committees, after investigation of each subject, the best fundamental methods are recommended, discussed, and adopted at the annual meetings. This procedure has been the means of providing standard practices for the purchasing and distribution of materials which has effected savings for the railroads. The more important recommendations include standard rules for railroad stores department operation (standard stock book and master stock book), standard rules for railroad purchasing department operation, standard material classification, standard scrap classification, standard reclamation practices, unit piling of material (a standard practice for storing and caring for materials and supplies), distribution of materials (standard plan for efficient handling and distribution of material to the users), standard types of stores department buildings and facilities, and standardization and simplification of stores stock.

American Railway Association, Telegraph and Telephone Section, W. A. Fairbanks, secretary, 30 Vesey Street, New York, N. Y.—This section functioning as a part of the operating division, American Railway Association, is continuing the activities of the former Association of Railway Telegraph Superintendents. It has prepared rules and specifications relating to telegraph and telephone com-

munication for railroad requirements. It has made a special study of the physical hazard and inductive interference of adjacent high-tension electrical lines and, in cooperation with the National Bureau of Standards and the State commissions, has obtained better protection against the hazards to life and property and reduced inductive interference at high-tension crossings. Sixteen standing committees are actively engaged in carrying on the work of the section. Consideration is being given to over 100 subjects, including the following important groups: Outside plant, inside plant, protection against electrolysis, electrical protection, message traffic, communication transmission development, and radio and wire carrier systems. A loose-leaf manual and pocket handbook have been provided for use by engineering and supervisory forces, and field forces. These publications contain 101 recommendations and specifications.

American Railway Car Institute, W. C. Tabbert, secretary, 61 Broadway, New York, N. Y. Among the objects of the association is to cooperate with railroads and other purchasers and with allied industries for the purpose of bringing about a standardization of designs and specifications and a uniformity of methods of purchasing and inspection. It cooperates with various agencies, such as Government bureaus and related organizations, especially the American Railway Association, in working on the standardization of specifications and designs of freight cars.

American Railway Engineering Association, E. H. Fritch, secretary, 431 South Dearborn Street, Chicago, Ill. This association functions also as the engineering division of the American Railway Association. As such it is divided into three sections—construction and maintenance, electrical, and signal. Each of these sections has its own committees dealing with special problems which are organized through a committee of direction, the individual members being selected from the various railroads. Their reports are considered at annual meetings of the sections, and when approved are submitted to letter ballot of the section membership and if approved by the section and the general committee of the division and by the board of directors of the American Railway Association are issued in the association's Manual of Recommended Practice. In the construction and maintenance section are committees on roadway; ballast; ties; rails; track; buildings; wooden bridges and trestles; masonry; signs, fences, and crossings; records and accounts; rules and organization; water service; yards and terminals; iron and steel structures; economics of railway location; wood preservation; uniform general contract forms; economics of railway operation; economics of railway labor; shops and locomotive terminals; a special committee on stresses in railroad track; and a special committee on standardization. In the electrical section are committees on electricity, overhead and

third-rail working conductors and crossings of power and other service wires. In the signal section are committees on mechanical interlocking, power interlocking, direct-current automatic block signaling, maintenance rules and instructions, standard designs, direct-current relays, alternating-current automatic block signaling, wires and cables, signaling practice, batteries, contracts, electrical testing, lightning protection, valuation, oils, pole lines, direct-current track circuits, electric railway track circuits, electric railway signaling, and highway crossing protection. The association is represented on the joint committee on standard specifications for concrete and reinforced concrete (with four other organizations), on the joint committee on studies of boiler feed-water problems (with four other organizations), and on the joint committee on concrete culvert pipe (with six other organizations). It is joint sponsor for two sectional committees functioning under the rules of procedure of the American Engineering Standards Committee as follows: Insulated wires and cables for other than telephone and telegraph use (with nine other organizations), and specifications for railroad ties (with the United States Forest Service). The association and its sections are represented on 32 additional sectional committees functioning under A. E. S. C. procedure.

American Short Line Railroad Association, T. F. Whittelsey, secretary, International Building, 1319 F Street NW., Washington, D. C. Although it has not as yet formulated or adopted any standards or specifications officially, the association has organized a purchasing department conducted under the name of the Consolidated Purchasing Agency. Moreover it is cooperating in the preparation of standards and specifications through official representation on 16 sectional committees functioning under the procedure of the American Engineering Standards Committee.

American Society of Agricultural Engineers, Raymond Olney, secretary, St. Joseph, Mich. The society has developed a standard testing and rating code for farm tractors that has been adopted by the farm-equipment industry, and its standards committee at the present time is formulating a very comprehensive program involving all phases of the application of engineering to agriculture, including farm power and machinery, farm structures, land reclamation, and rural electrification.

American Society of Civil Engineers, George T. Seabury, secretary, 33 West Thirty-ninth Street, New York, N. Y. Research and standardization work of the society is carried on by special committees appointed by the board of direction. Such committees have been organized to deal with the following subjects: Codify present practice on the bearing value of soils for foundations; stresses in railroad track, bridge design and construction, standard construction

contracts, electrification of steam railways, flood-protection data, hydraulics phenomena, impact in highway bridges, irrigation hydraulics, concrete and reinforced concrete arches, steel column, cement, engineering contract bonding, and arbitration. A special committee has been appointed to study the effects of earthquakes on engineering structures, with special reference to the Japanese earthquake of September 1, 1923. The society is represented on the joint committee on standard specifications for concrete and reinforced concrete (with four other organizations), and on the joint concrete culvert pipe committee (with six other organizations). It is joint sponsor for three sectional committees functioning under the rules of procedure of the American Engineering Standards Committee, as follows: Structural steel shapes (with the Association of American Steel Manufacturers and the Society of Naval Architects and Marine Engineers), manhole frames and covers (with the telephone group of the A. E. S. C.), and scientific and engineering symbols and abbreviations (with four other organizations). It is officially represented on 19 additional sectional committees functioning under A. E. S. C. procedure.

American Society of Heating and Ventilating Engineers, A. V. Hutchinson, secretary, 29 West Thirty-ninth Street, New York, N. Y. The society has developed and adopted codes for the testing of heating boilers and ventilating fans and has established a method for testing ventilation. It has received the cooperation of the American Society of Mechanical Engineers and the Heating and Piping Contractors National Association in the revision of its code for testing low-pressure boilers. Its present research program includes investigation of a standard method of estimating radiation quantities, determination of pipe sizes for heating systems, heat transmission through building materials, infiltration of air into buildings, rating of low-pressure heating boilers, and work on heat, humidity, and air motion, at its research laboratory conducted at the Pittsburgh Experiment Station of the United States Bureau of Mines. In cooperation with this association and the United States Department of Commerce the society has been able to eliminate the steam type of radiator in favor of the water type, which has been found to be thoroughly satisfactory for steam heating. In cooperation with the National Association of Fan Manufacturers and the American Society of Mechanical Engineers it has developed a standard test code for disk and propeller fans, centrifugal fans, and blowers. It cooperated with the National Education Association in the preparation of a code on schoolhouse planning. The society is sponsor for two sectional committees functioning under the rules of procedure of the American Engineering Standards Committee, as follows: Ventilation safety code and safety code for exhaust systems. It is officially represented on six sectional committees functioning under A. E. S. C.

procedure. Work has been going forward for three years in the development of a Code of Minimum Requirements for the Heating and Ventilation of Buildings, which probably will be completed and issued in 1927.

American Society of Mechanical Engineers, Calvin W. Rice, secretary, 29 West Thirty-ninth Street, New York, N. Y. The society has organized a number of professional divisions, each composed of a group of members interested in a particular phase of mechanical engineering, including fuels, steam power, oil and gas power, machine-shop practice, printing machinery, wood industries, textiles, petroleums, railroads, materials handling, and aeronautics. For the purpose of formulating standard specifications for the construction of steam boilers and other pressure vessels and for their care in service the society has organized the boiler code committee, which has formed 10 working subcommittees. Through cooperation with other organizations the society's boiler code has been officially adopted in 19 States and 15 cities. A main committee on power-test codes has been organized to determine what codes should be developed, to nominate persons for appointment as members of the individual working committees, and transmit proposed codes, with recommendations, to the council of the society. Nineteen individual committees are now working on power-test codes. A standing safety committee of five members has been organized to supervise the society's safety promotion work. The society has also organized a main research committee of five members, under the supervision of which special research committees have been formed to deal with lubrication, bearing metals, fluid meters, properties of steam, gears, cutting and forming of metals, mechanical springs, effect of temperature on the property of metals, condenser tubes, boiler furnace refractories, elevator safeties and other devices, boiler feed water (joint committees of five societies), highway research (advisory board of National Research Council), nonferrous metals, properties of refractory materials and nondestructive testing of wire rope (advisory committees of the National Bureau of Standards), and heat treatment of rock-drill steel (advisory board of the National Bureau of Standards and the United States Bureau of Mines). The main standardization committee has been organized to supervise the dimensional standardization work of the society, and the work of the sectional committees functioning under the procedure of the American Engineering Standards Committee. It makes recommendation concerning proposed standards and codes to the council for action after the final draft has been approved by the proper standing committee subsequent to review of the proposed standards or codes at a regular business session of the society and circulation to the membership and interested individuals through the medium of the society's monthly journal. The

society is sponsor or joint sponsor for 25 sectional committees, as follows: Identification of piping systems (with the National Safety Council); elevators (with the American Institute of Architects and the American Institute of Electrical Engineers); safety codes for elevators and escalators (with the American Institute of Architects and the National Bureau of Standards); pipe thread (with the American Gas Association); plain limit gauges and gauging systems for general engineering work; small tools and machine tool elements (with the National Tool Builders Association); gears (with the American Gear Manufacturers' Association); safety code for mechanical power transmission apparatus (with the International Association of Industrial Accident Boards and Commissions and the National Bureau of Casualty and Surety Underwriters); pipe flanges and fittings (with the Heating and Piping Contractors National Association and the Manufacturers Standardization Society of the Valve and Fittings Industry); national code for compressed air machinery (with the National Safety Council, American Society of Safety Engineers—engineering section); safety code for conveyors and conveying machinery (with the National Bureau of Casualty and Surety Underwriters); safety code for mechanical power control (with the National Bureau of Casualty and Surety Underwriters); screw threads for fire-hose couplings (with the American Water works Association and the National Board of Fire Underwriters); transmission chains and sprockets (with the American Gear Manufacturers' Association and the Society of Automotive Engineers); safety codes for cranes, derricks, and hoists; scientific and engineering symbols and abbreviations (with four other organizations); standards for drawings and drafting-room practice (with the Society for the Promotion of Engineering Education); standards for graphics; safety code for high pressure piping; shafting; and the following sectional committees as joint sponsor with the Society of Automotive Engineers: Standardization and unification of screw threads; ball bearings; bolt, nut, and rivet proportions; pins and washers (machine elements); and wire and sheet metal gauges. The society is represented on 33 additional sectional committees functioning under A. E. S. C. procedure. During 1926 it maintained two research associates at the National Bureau of Standards doing research work on the properties of steam.

American Society for Municipal Improvements, C. W. S. Sammelman, secretary, 315 Commercial Building, St. Louis, Mo. Committees of the society are at work revising the existing specifications relating to bituminous brick, cement concrete, stone block and wood block pavements, sidewalks, and curbs. They have prepared specifications for broken stone and gravel roads and for sewers. A standard municipal contract form has also been prepared. The society's specifications are used as guides for municipal engineers. They are

kept in harmony with the current specifications of the American Society for Testing Materials. These two societies and the American Association of State Highway Officials and the United States Bureau of Public Roads are joint sponsors for the sectional committee on method of test for penetration of bituminous materials functioning under the rules of procedure of the American Engineering Standards Committee. The society is officially represented on 24 additional sectional committees functioning under A. E. S. C. procedure.

American Society of Refrigerating Engineers, W. H. Ross, secretary, 35 Warren Street, New York, N. Y. The society has officially adopted a test code for steam driven ice manufacturing plants, a standard ton for refrigeration, specifications for synchronous motors for direct-connected ammonia compressors, and test code for refrigerating systems. The last mentioned was formulated in cooperation with the American Society of Mechanical Engineers. It is serving as sponsor for the sectional committee on safety code for mechanical refrigeration and is officially represented on seven additional sectional committees functioning under A. E. S. C. procedure.

American Society of Safety Engineers. (See National Safety Council.)

American Society for Steel Treating, W. H. Eiseman, secretary, 4600 Prospect Avenue, Cleveland, Ohio. This society has organized a recommended practice committee to act in a supervisory capacity with reference to both the subject matter and the personnel of technical committees of the society. When approved by the recommended practice committee, the report of a technical committee is issued in tentative form for a period of about one year. When reviewed, revised, and approved by the board of directors and the recommended practice committee, it is adopted as a standard recommended practice of the society. Technical committees are now at work on the following subjects: Tool steel, measuring case depth, heat treatment of water and oil hardening gears, hardness testing of metals, mechanism of cementation, carburization of small parts, and the heat treatment of crane chains, steel castings, wrought aluminum alloys, carbon steels, and piston pins. The society is represented on the joint committee on definitions of terms relating to heat treatment (with the American Society for Testing Materials and the Society of Automotive Engineers) and other cooperative committees of these societies and the American Society of Mechanical Engineers, National Research Council, United States Bureau of Mines, the National Bureau of Standards, and the War Department.

American Specification Institute, Gardner C. Coughlen, acting executive secretary, 160 North La Salle Street, Chicago, Ill. As an important step in the development of standardized specifications to

accompany drawings for building construction and equipment, the institute issues the Specification Record, comprising bulletins, specifications, outlines of specifications, and other corelated data. Specifications and information collected by the institute from other organizations and sources are made available for the use of institute members by actual distribution in the form of bulletins and the Specification Record.

American Vitrified China Manufacturers Association, W. B. Kerr, president, care of Iroquois China Co., Syracuse, N. Y. This association has taken an active part in the elimination of excess sizes and varieties of chinaware under the auspices of the division of simplified practice, having cooperated in the initiation and formulation of simplified practice recommendations relating to chinaware for hotels, dining cars, hospitals, cafeterias, and restaurants.

American Water Works Association Council of Standardization, George W. Fuller, chairman, 170 Broadway, New York, N. Y. The association has organized committees to deal with private fire protection services, standard specifications for water meters, standard brass fittings, and standard form of contract, and is officially represented on the American Committee on Electrolysis. In 1920 it set up the standardization council, which is practically a committee on committees. The personnel of committees functioning under the council is generally decided at conventions in conference with officers of the association. The council makes interim replacements when committeemen are not able to serve. The committees report to the council as to plan and scope, and the council passes on reports before they are released. Eight committees are now fuctioning in preparing material for a revised edition of the Manual of Water Works Practice, issued about a year ago, as follows: Methods of water analysis, practicable loadings for purification processes, industrial wastes in relation to water supply, pumping station betterments, physical standards for distribution system, standard specifications for cast-iron pipe and specials, service connection practice, filter sand testing and recording, boiler feed water studies. The council has added committees on steel standpipes and water towers and steel pipe lines. In cooperation with the American Public Health Association, the American Water Works Association publishes Standard Methods of Water Analyses, the sixth edition of which was issued in 1925. In cooperation with four other organizations the association is making a study of boiler feed water problems. The association is joint-sponsor for two standardization projects under the rules of procedure of the American Engineering Standards Committee, as follows: Specifications for cast-iron pipe and special castings (with three other organizations), and screw threads for fire-hose couplings (with the American Society of Mechanical Engineers and the National Board of

Fire Underwriters). It is officially represented on three additional sectional committees functioning under A. E. S. C. procedure.

American Welding Society, M. M. Kelly, secretary, 29 West Thirty-ninth Street, New York, N. Y. Among the stated functions of the society are that of providing an organization for the promulgation of standards in the welding field, and the bringing about of the extension of the use of welding through research work. For the purpose of joining with other societies, associations, and Government departments in cooperative research and standardization in welding, the society has organized the American Bureau of Welding, which coordinates and controls all research and standardization in welding of the society and also acts as the welding research department of the National Research Council. (See American Bureau of Welding.)

American Wood Preservers' Association, E. J. Stocking, secretary, 111 West Washington Street, Chicago, Ill. One of the duties assigned to the executive committee is the printing of a Manual of Recommended Practice in which are published the specifications and standards approved by the association. Proposed standards or specifications which are embodied in a report of a standing or special committee are published and distributed to the membership prior to the annual meeting. If approved by the majority of the voting members present at the annual meeting, the report is submitted to letter ballot of the association, and is considered approved if it receives a majority of the votes cast by letter ballot. At the 1926 annual meeting, reports relating to the revisions of old material in, and the addition of new material to, the manual were presented by committees on the following subjects: Preservatives, ties, treatment of Douglas fir ties, treatment of car lumber and fir piling, nonpressure treatment of poles, inspection, tie-service records, posts, and steam treatments. The association is represented on the joint committee on methods of test for petroleum oils for wood preservation (with the American Society for Testing Materials), and the national committee on wood utilization. It is represented on three sectional committees functioning under rules of procedure of the American Engineering Standards Committee.

American Zinc Institute, Stephen S. Tuthill, secretary, 27 Cedar Street, New York, N. Y. Standardization activities of the institute are confined to cooperation with other organizations, especially the American Society for Testing Materials. It is joint sponsor with the A. S. T. M. for the sectional committee on zinc and zinc ores and is officially represented on four additional sectional committees under A. S. T. M. sponsorship and functioning under A. E. S. C. procedure.

Asbestos Paper Manufacturers' Association, Donald Tulloch, jr., secretary, 246 North Seventeenth Street, Philadelphia, Pa. In rec-

ognizition of the desirability of minimizing the number of sizes, weights, and thicknesses of asbestos paper and millboard this association initiated the survey of the asbestos manufacturing field which resulted in the formulation of the simplified practice recommendation relating to asbestos paper and asbestos millboard.

Asphalt Association, The, J. E. Pennypacker, secretary, 441 Lexington Avenue, New York, N. Y. This association has no standardizing committee designated as such, its work of standardization being carried on in cooperation with various interested organizations. However, its technical advisory committee prepares specifications for materials and methods of construction, which are distributed widely and recommended for general use. Wherever possible these specifications make use of recognized standards adopted by some national organization. The principal organizations with which the association is cooperating are the American Society for Testing Materials, the American Society for Municipal Improvements, and the division of simplified practice of the United States Department of Commerce in connection with the elimination of unnecessary grades of asphalt. The association is conducting research which will tend toward standardization of certain details of paving mixture design, this work being done in cooperation with the Association of Asphalt Paving Technologists.

Asphalt Shingle and Roofing Association, J. S. Bryant, secretary, 285 Madison Avenue, New York, N. Y. Although the association has formulated no specifications, members of the association have cooperated actively with the Underwriters' Laboratories, the Federal Specifications Board, and the American Society for Testing Materials in the preparation of specifications for roofing products. All of the members of the association, by official unanimous resolution, have signified their willingness to supply asphalt and roofing materials complying with Federal Government master specifications. The association maintains a research associate at the National Bureau of Standards doing research work, on the relative value of different fibers used in roofing felt.

Associated Cooperage Industries of America, C. G. Hirt, secretary and manager, B–20 Railway Exchange Building, St. Louis, Mo. Organized for the purpose of promoting the cooperage business and protecting the traffic interests of its members. The association includes among its various activities the establishment and maintenance of uniform grades for barrel material, and standard specifications for various types of cooperage. It has adopted grade rules and specifications covering both slack and tight cooperage stock, which are made effective by vote of a majority of the membership of the respective groups. Whenever called upon to do so the executive committee investigates any complaint filed by members for

violation of its code of ethics or unfair dealing and takes such action thereon as the circumstances may require. An inspection service is maintained to pass upon the quality of cooperage material, in accordance with the established grade rules and specifications, at either the mill yard or destination. It is furnished on the request of members, when made in compliance with the association's inspection rules.

Associated Factory Mutual Fire Insurance Companies, Inspection Department, H. O. Lacount, manager, 184 High Street, Boston 9, Mass. In connection with its work to improve the construction of buildings, afford better fire protection, and establish a basis for proper selection, installation, and operation of fire-fighting apparatus, the association has formulated a large number of specifications for water-supply equipment, sprinkler systems, fire-protective appliances, etc. Firms manufacturing apparatus in accordance with the specifications of the association are permitted to use the association's identification mark on devices specifically approved by the association as to both design and construction. The inspection department also issues a monthly publication covering the loss experience of the Factory Mutual companies and matters of special interest from the standpoint of fire safety. As a member of the fire-protection group the association is joint sponsor for two sectional committees functioning under the rules of procedure of the American Engineering Standards Committee, as follows: Specifications for fire tests of materials and construction (with the American Society for Testing Materials and the National Bureau of Standards) and specifications for rubber-lined fire hose (with the American Society for Testing Materials). This group is represented on one additional sectional committee functioning under A. E. S. C. procedure.

Associated General Contractors of America (Inc.), R. C. Marshall, jr., general manager, 1150 Munsey Building, Washington, D. C. This association is pursuing the work of standardization along two lines: First, the initiation and development of its own standards at present confined to construction equipment, and second, cooperating with other standardizing bodies, such as the American Engineering Standards Committee, Federal Specifications Board, Department of Commerce, and others. In cooperation with equipment manufacturers who, with each line of equipment, form a bureau affiliated with the Associated General Contractors, the association is developing what are known as "A. G. C. standards." So far this work has been practically completed with respect to concrete mixers, the manufacture of which is governed by "A. G. C. mixer standards." The unusual feature of the standardization is that the producer group submits its tentative standards to the association as representing the consumer, and together they work out standard recommendations,

which are mutually agreed upon. The products thus standardized carry a plate designating that they comply with "A. G. C. standards," and the manufacturers desire that the association members act to prevent violation and discarding of the standards, except by mutual consent. The manufacturers enter into agreement with the association to abide by the "A. G. C. standards," and the association is given the right to deny the use of the name plate by any manufacturer who breaks the agreement. The work of standardizing equipment is not only concerned with the question of mechanics, but is also closely linked with selling practices, which in the past have been detrimental to both the producer and the consumer. At the present time the way is being paved for the standardization of power shovels and cranes, which will probably begin with the matter of sizes.

Associated Knit Underwear Manufacturers of America, Roy A. Cheney, secretary, Union Station, Utica, N. Y. Members of the standardization committee of the association are appointed by the president to represent various manufacturing groups. In cases where problems are of joint interest, associations of jobbers and retailers appoint one or more members to serve on the standardization committee, the meetings of which are attended by representatives of the United States Department of Commerce. This committee has authority to make recommendations to the association concerning the work done on association problems by the research associate at the National Bureau of Standards, and as to any new problems suggested by members of the association. Its recommendations become effective when approved by a majority vote at the general meeting of the association. The association has adopted a standard method of testing the breaking strength of knitted fabrics and standard sizes for various kinds of cotton, wool, and wool-cotton underwear for men and union suits for boys. Work is now being done on the standardization of two-piece suits for boys and various kinds for infants; the development of instructions for washing knit rayon underwear, and the simplification in sizes of fiber shipping containers. The association has organized a committee to cooperate with the Federal Specifications Board in the preparation of knit underwear specifications. This committee has assisted in the formulation of standard sizes for men's, boys', and children's knit cotton union suits. The association has adopted a standard mark, protected by law, to be used by manufacturers on garments made to measurements certified to conform to tables compiled by the National Bureau of Standards under license from the association. A committee composed of jobbers, retailers, and manufacturers has the right to revoke the license upon due proof that the use of the standard mark has been wilfully and knowingly abused.

Associated Metal Lath Manufacturers, Wharton Clay, commissioner, 123 West Madison Street, Chicago, Ill. Standardization activities of the association have been confined largely to the elimination of excess varieties and sizes of metal lath. In this work it has cooperated with other organizations through the division of simplified practice of the United States Department of Commerce. The association is cooperating in the activities of the American Concrete Institute, American Construction Council, American Society for Testing Materials, National Federation of Construction Industries, and National Fire Protection Association. The association is represented on two sectional committees functioning under the procedure of the American Engineering Standards Committee.

Associated Tile Manufacturers, F. W. Walker, secretary, Beaver Falls, Pa. In recognition of the desirability of establishing uniform grade nomenclature, formulating minimum grade specifications, and eliminating excess sizes and varieties of tiles, this association initiated the movement which resulted in the development of the simplified practice recommendation relating to white glazed tiles and unglazed ceramic mosaic, including a color scheme for grade marking and the issuing of package grade or master grade certificates.

Associates for Government Service, The, (Inc.), E. Stagg Whitin, president, 730 Fifth Avenue, New York, N. Y. One of the important functions of the associates is to assist State and city governments in coordinating their purchases under selected commodity specifications. It has formulated specifications for commodities manufactured in the prisons of one State and sold to purchasing departments of other States. The association has made special effort to have its specifications conform to those used by commercial organizations in order to assist State purchasing agents in securing commodities produced in general industry to supplement prison goods that are uniform in quality with prison-made goods. The association has compiled a list of manufacturers of other than prison goods who are willing to certify that commodities manufactured by them for the purpose conform to the requirements and tests of the prison-made goods specifications. After securing the advice of the trade concerning both the fairness of price and the ability of these firms to manufacture in accordance with the specifications, the association agrees to certify the goods to the State purchasing agents and recommend them for their use. The agreements made are for a limited period and carry with them conditions as to inspection at the source of production with penalties for failure to meet the specifications. The association was officially represented on the advisory board which cooperated with the United States Department of Commerce in the preparation of the National Directory of Commodity Specifications.

Association of American Steel Manufacturers, J. O. Leech, secretary, care of Carnegie Steel Co., Pittsburgh, Pa. Standardization has occupied an important place in the activities of this association for 30 years. It has issued specifications for structural and boiler steel, concrete reinforcement bars, steel rails, and tie plates, and bar steels; and has formulated methods of sampling steel for check analysis and established permissible rolling variations in the size and weight of hot-rolled bars and bar sizes of angles, tees, zees, and channels. The association is represented on the Joint Committee on Investigation of the Effect of Phosphorus and Sulphur in Steel (with 10 other organizations). It is joint sponsor, with the American Society of Civil Engineers and the Society of Naval Architects and Marine Engineers, for the sectional committee on structural steel shapes functioning under the rules of procedure of the American Engineering Standards Committee. It is represented on three additional sectional committees functioning under A. E. S. C. procedure.

Association of Edison Illuminating Companies, Preston S. Millar, secretary, Eightieth Street and East End Avenue, New York, N. Y. While promotion of the work of standardization is not one of the primary functions for which this association was originated, it is, nevertheless, joint sponsor for two sectional committees functioning under the rules of procedure of the American Engineering Standards Committee, as follows: Insulated wires and cables for other than telephone and telegraph use (with nine other organizations), and rules for electricity meters (Code for Electricity Meters) (with the National Bureau of Standards and National Electric Light Association). As a member of the electric light and power group, it is sponsor for the sectional committee on miscellaneous line materials. It is also represented on 20 sectional committees functioning under the A. E. S. C. procedure.

Association of Electragists, International, Laurence W. Davis, general manager, 15 West Thirty-seventh Street New York, N. Y. The association is making a survey of the types of rigid conduit used for electrical installations looking toward simplification to be carried forward under the procedure of the division of simplified practice of the United States Department of Commerce. It has organized a committee on electragists standards for wiring installations. The association is joint sponsor with the American Institute of Architects and the American Institute of Electrical Engineers for a sectional committee on symbols for electrical equipment of buildings, functioning under the rules of procedure of the American Engineering Standards Committee. It is represented on three additional committees functioning under A. E. S. C. procedure.

Association of Feed Control Officials of the United States, A. W. Clark, secretary, New York State Agricultural Experiment Station,

Geneva, N. Y. One of the important activities of this organization is the formulation of standards and the adoption of definitions for feeding stuffs. Revisions and adoptions of new standards and definitions are submitted by committees in the form of recommendations for approval of the executive committee. The recommendations are then presented by the executive committee to the association for adoption as standards and definitions, and are published in pamphlet form under the title of Definitions of Feeding Stuffs. This association has adopted a uniform feed law, which is being used as a model for adoption by the various States. It is at present engaged in the preparation of a yearbook which will contain the definitions and standards, uniform registration forms, uniform labels for different types of feeding stuffs, recommendations for labeling, and registration of mineral mixture feeds that have been adopted by the association, as well as other information relating to the work of the association. It cooperated with the Federal Specifications Board in the formulation of the United States Government master specifications for feeds and forage.

Association of Governmental Labor Officials of the United States and Canada, Louise E. Schutz, secretary, 612 Bremer Arcade, St. Paul, Minn. The association is composed of the officials of the departments of labor and industry of the various States and Provinces. Its standardization activities have been confined largely to the formulation and promulgation of industrial safety codes. By formal resolution the president was authorized to appoint a committee on uniform safety laws in order to facilitate the adoption of uniform safety codes in the States. It has organized a standing committee on uniform statistical nomenclature, with the United States Commissioner of Labor Statistics as chairman, to formulate a standard plan for compiling industrial statistics to assist in accident prevention. It has urged the adoption by the State departments of the safety codes developed in cooperation with the American Engineering Standards Committee. The association is joint sponsor, with the Laundryowners National Association and the National Association of Mutual Casualty Companies, for the sectional committee on safety code for laundries functioning under A. E. S. C. procedure. It is represented on 13 additional safety-code sectional committees.

Association of Iron and Steel Electrical Engineers, J. F. Kelly, secretary, Empire Building, Pittsburgh, Pa. Standardization is an important activity of this association. It has formulated and adopted rules for the safe operation of electric overhead traveling cranes, and general specifications for these cranes, and also for engine stops, commutating pole mill type motors, and alternating-current motors for main roll drive. It is officially represented on the sectional committees on electrical safety code and safety code for the

protection of the heads and eyes of industrial workers, functioning under A. E. S. C. procedure.

Association of Manufacturers of Chilled Car Wheels, G. E. Doke, president and secretary, 1847 McCormick Building, Chicago, Ill. Although this association has adopted no specifications, it has cooperated with the American Railway Association, mechanical division, in the formulation of specifications for cast-iron wheels for locomotives, tenders, and cars, and has a completely equipped chemical and physical research laboratory.

Association of Official Agricultural Chemists, The, W. W. Skinner, secretary, Box 290, Pennsylvania Avenue Station, Washington, D. C. One of the important functions of this association is the formulation of standards and methods of analysis for agricultural products and other materials used in the agricultural industry. Representatives appointed by the president serve with members of the American Association of Dairy, Food, and Drug Officials and of the United States Department of Agriculture, on the joint committee on definitions and standards for food products. The association cooperates with the American Public Health Association in the preparation of standard methods of milk analysis, and with the committee on revision of the United States Pharmacopœia in the revision of the methods of tests for medicinal products. This association has published a book of methods of analysis, and these methods are accepted as authoritative in matters at issue before the Federal and State courts.

Association of Railway Electrical Engineers, J. A. Andreucetti, secretary, 413 Chicago & North Western Terminal, Chicago, Ill. Being interested particularly in the operation rather than the manufacture of electrical apparatus used on railroads, this association has taken no part officially in the formulation of dimensional standards for such apparatus. However, it has adopted performance specifications for short-time-duty electric motors and has prepared recommendations concerning the operation of train lighting, locomotive lighting, train-control equipment, manual on standard illumination for railway buildings and standardization of electric construction and maintenance practice, and electric welding and heating practice. The association is joint sponsor, with nine other organizations, for the sectional committee on insulated wires and cables for other than telephone and telegraph use and is officially represented on the sectional committee on electrical safety code functioning under A. E. S. C. procedure.

Better Bedding Alliance of America, S. J. Mills, secretary, 440 South Dearborn Street, Chicago, Ill. Among the stated objects of this association is the encouragement of proper labeling of bedding and the discouragement of any practice of deception. Its committee on publicity has been engaged actively in conducting educational

publicity to show the public what to buy in mattresses. It cooperated in the establishment of recognized types and sizes of beds, springs, and mattresses under the auspices of the division of simplified practice.

Bureau of Explosives, Col. B. W. Dunn, chief inspector, 30 Vesey Street, New York, N. Y. This bureau functions as an agency for cooperation between the Interstate Commerce Commission and the American Railway Association so far as concerns the standardization of containers for explosives and other dangerous articles. Specifications for such containers are published by the bureau in accordance with the regulations of the commission. The bureau maintains a chemical laboratory for the study of explosives and containers, and a force of traveling inspectors to insure compliance with the requirements of the specifications.

Canners League of California, Preston McKinney, vice president and secretary, 112 Market Street, San Francisco, Calif. Fruit and vegetable standards formulated by committees of this organization appointed by its board of directors have been widely adopted. Its standard contract for canned foods has been formally approved by the National Wholesale Grocers Association. Working in cooperation with growers' associations and the California Development Association, the league has secured the passage of a law which requires that all canned peaches, pears, apricots, and cherries of a grade below standards be marked with the word "seconds," embossed in the top of the can. Working in conjunction with the California State Board of Health, it has secured the passage of the canned vegetable inspection act, which provides protection to the entire industry against the processing of vegetables susceptible to botulinus in a manner which is not safe. The league has adopted buying sizes for cherries and plums. It cooperated with the California Canning Peach Growers in further improving the terms of buying contracts, both as to size of fruit and method of receiving. It has formulated specifications for canned fruits and issued a booklet containing not alone standards but digest of the new "seconds" law, prorata delivery rules, etc. Its preserving section has adopted specifications and instructions to inspectors on strawberries and approved standards on fresh-fruit preserves and jelly.

Chamber of Commerce of the United States of America, Department of Manufacture, E. W. McCullough, manager, Washington, D. C. During the six years of its existence this department has been cooperating actively with the United States Department of Commerce in the movement toward the elimination of waste in industry through standardization and simplification. Because of its friendly relations with business, the chamber of commerce has maintained contact with over 750,000 firms, corporations, and others

engaged in business covering practically every avenue of industry. Through these relations with industry it has been able to act in a liaison capacity in bringing forward from time to time trade groups, both organized and unorganized, in which it has stimulated interest in the program for waste elimination. Many of these groups had arrived at the point where they were ready to reach a determination as to a simplified practice program. In the course of the past six years many such groups have been brought in contact with the division of simplified practice, and the work taken up from that point and carried on in many instances to successful consummation. It has assisted the United States Department of Commerce in explaining to industry the service which it is rendering and has urged the need for cooperation in many lines of industry in order to carry on the work. It has suggested to many manufacturing groups concerned in the establishment of definite standards both as to their materials and products the advisability of maintaining contact with the National Bureau of Standards. Through its department of manufacture, the chamber of commerce has in many cases cooperated with the division of simplified practice in the formulation of simplified practice recommendations. It is officially represented on the planning committee acting in an advisory capacity to the division of simplified practice, and on the advisory board which cooperated with the United States Department of Commerce in the preparation of the National Directory of Commodity Specifications. The organization is officially represented on two sectional committees functioning under the rules of procedure of the American Engineering Standards Committee.

Clay Products Association, George C. D. Lenth, secretary, 913 Chamber of Commerce Building, Chicago, Ill. This association is made up of manufacturers of vitrified salt glazed clay sewer pipe, drain tile, wall coping, segmental block, and flue lining. The association maintains a fellowship at Mellon Institute of Industrial Research where studies are being made on the processes of the manufacturing of the above, as well as improvements in manufacturing. The association has several committees, among which is the committee on standardization, which has been in close cooperation with the National Bureau of Standards. The association, in addition to having membership in technical organizations of various kinds, is a member of the American Society for Testing Materials and has adopted that society's specifications for clay sewer pipe and drain tile. The association has a staff of engineers for the purpose of promoting its commodities and for the education of engineers and users of their products.

Coal Mining Institute of America, H. D. Mason, jr., secretary, Edensburg, Pa. This organization takes an active part in the mining standardization work going forward under the auspices of the Ameri-

can Engineering Standards Committee. It inaugurated the movement which resulted in the calling of the conference of coal producers, dealers, and consumers which recommended the formation of a sectional committee on the classification of coal based upon chemical and physical characteristics. It is officially represented on 10 sectional committees functioning under A. E. S. C. procedure.

Common Brick Manufacturers' Association of America, Ralph P. Stoddard, secretary, Guarantee Title Building, Cleveland, Ohio. This association, in cooperation with the American Face Brick Association, submitted to the division of simplified practice the resolution which resulted in the conference at which the industry adopted a standard size for face brick and common brick. The association maintains two research associates at the National Bureau of Standards investigating the loading capacities of different grades of brick in an attempt to establish specifications for common brick. The association cooperated in the initiation of the work on the building code committee of the United States Department of Commerce.

Compressed Gas Manufacturers Association, J. H. Luening, secretary, 120 West Forty-second Street, New York, N. Y. Many standardization activities of this association are conducted under the auspices of the American Engineering Standards Committee. With the American Gas Association and the International Acetylene Association it forms the gas group of the A. E. S. C. It is officially represented on the sectional committees on identification of piping systems, and safety codes for gas, mechanical refrigeration, and compressed air machinery, functioning under A. E. S. C. procedure. The association also cooperates with the Bureau of Explosives in assisting the Interstate Commerce Commission in the preparation of specifications covering gas transportation equipment. Other standards for equipment used in the compressed-gas industry are also developed from time to time as association standards.

Concrete Products Association, D. R. Collins, secretary, 4715 State Street, Milwaukee, Wis. Although this association has not formulated any standards or specifications, it has devised ways and means for insuring that its members manufacture products to meet the requirements of certain nationally recognized specifications, such as those of the American Concrete Institute and the American Society for Testing Materials. The association issues certificates of quality to its members when it is found that their products meet the requirements of the American Concrete Institute standards. Before a member can receive a certificate of quality, his product is tested by a representative of the association to ascertain whether or not it meets the requirements. These certificates are good for only the balance of the membership year, and renewals can be obtained only upon tests made of new specimens.

Concrete Reinforcing Steel Institute, M. A. Beeman, secretary, Tribune Tower, Chicago, Ill. This organization initiated the movement which resulted in the establishment of a simplified list of sizes of steel reinforcing bars under the auspices of the division of simplified practice; also initiated the movement which resulted in a survey of current practice in steel spiral rods for concrete reinforcement, and is now studying the matter of one grade of new billet reinforcing steel.

Copper and Brass Research Association, George A. Sloan, secretary, 25 Broadway, New York, N. Y. The members of this association consist of copper-mining companies and copper and brass fabricating and distributing companies. The industrial units are represented on committees of the American Society for Testing Materials and are governed by specifications adopted by that society. The standardization activities of the association are undertaken in cooperation with other organizations, especially the A. S. T. M. It is officially represented on six sectional committees functioning under the rules of procedure of the American Engineering Standards Committee. It maintains two research associates at the National Bureau of Standards doing research work on the investigation of safe loading of corrugated copper roofing, etc.

Cordage Institute, J. S. McDaniel, secretary, 350 Madison Avenue, New York, N. Y. This organization has formulated and adopted standards for footage, nomenclature, and tensile strength of sisal, manila, and java ply and yarn goods. These standards are now in the process of being reviewed and expanded, the work being done with the cooperation of the division of simplified practice. A committee of the institute is working with the American Petroleum Institute in preparing standards of cordage use in oil-well production.

Cover Paper Manufacturers Association, E. H. Naylor, secretary, 44 Vernon Street, Springfield, Mass. This association has adopted and promulgated certain trade customs relating to cover paper, including standard sizes and weights.

Drill and Reamer Society, The, Herbert S. Blake, secretary, 120 Broadway, New York, N. Y. The standing committee on simplification and standardization is actively engaged in the task of eliminating from catalogue lists, sizes and styles of drills and reamers which the trade no longer demands, and is establishing proper standard basic mechanical sizes of these tools to be listed in revised catalogues. The membership acts upon the recommendations of the committee submitted at general meetings of the society.

Eastern Clay Products Association, Henry T. Shelley, secretary, Colonial Trust Building, Philadelphia, Pa. Among the committees appointed by the president to deal with standardization matters are: The standards committee, the Mellon Institute committee, the joint

standards committee, the A. S. T. M. committee, and the Mellon Institute joint committee. The last mentioned is composed of representatives of the Eastern Clay Products Association and the Clay Products Association, Chicago, which two associations maintain two joint fellowships at the Mellon Institute of Industrial Research. Matters relating to manufacturing problems are considered jointly by the standards committee of these associations. The Eastern Clay Products Association works in close harmony with the A. S. T. M. and has adopted that society's dimensions for sewer pipe, crushing strength, and methods of test. The association has so standardized the product of its members that all of them produce sewer pipe or chimney flue lining which meet standard definite requirements.

Electric Hoist Manufacturers Association, E. Donald Tolles, secretary, 165 Broadway, New York, N. Y. Specifications for portable overhead hoists so formulated as to be in harmony with the specifications of the American Institute of Electrical Engineers, the American Society for Testing Materials, and the Electric Power Club have been formally approved and promulgated by this association.

Electrical Safety Conference, Robert B. Shepard, secretary, 109 Leonard Street, New York, N. Y. The association is composed of representatives of seven cooperating and associate organizations interested in questions affecting accident hazards arising from the design, construction, installation, and use of electrical appliances. Committees are appointed to study and prepare electrical safety standards. The report of these committees are submitted to the conference and after approval and acceptance by its cooperating organizations are published as safety standards. The conference is sponsor for the sectional committee on safety code for electrical power control functioning under A. E. S. C. procedure.

Elevator Manufacturers Association of the United States, O. P. Cummings, secretary, 52 Vesey Street, New York, N. Y. This association has adopted a uniform form of contract, although it has formulated no specifications for elevators. However, it is officially represented on the sectional committee on elevators, and safety codes for elevators and escalators and for walkway surfaces, functioning under A. E. S. C. procedure.

Grain Dealers National Association, Charles Quinn, secretary, Toledo, Ohio. The standard grades of grain advocated by the association are those prepared by the United States Department of Agriculture in accordance with the grain standards act passed by Congress. In its effort to insure adherence to these standards by its members, the association has written into its by-laws a clause, according to which any member found guilty by the Department of Agriculture of a violation of this act stands expelled automatically.

from the association, and notice of the expulsion is published in the association's official organ.

Grinding Wheel Manufacturers Association of the United States and Canada, F. R. Henry, secretary, Summit Street and Negley Place, Dayton, Ohio. The activities of this association have been confined to the standardization and simplification of grinding wheels. It has adopted standard shapes for grinding wheels and attachments established at a general conference called by the division of simplified practice at the request of this association. It is joint sponsor with the International Association of Industrial Accident Boards and Commissions for the sectional committee on safety code for the use, care, and protection of abrasive wheels functioning under A. E. S. C. procedure.

Gypsum Industries, The, H. J. Schweim, chief engineer, 844 Rush Street, Chicago, Ill. This organization appointed a technical problems committee to review all specifications published by the Gypsum Industries, arrange for the conducting of tests, outline problems, and investigations for the research associates of this organization at the National Bureau of Standards, and handle all problems of a technical nature for the industry. This committee usually holds meetings about every two months. Through the work of this committee the organization has prepared and issued literature relating to the properties and uses of gypsum, and certain suggested provisions for building codes. It has also issued revised specifications for the application of gypsum plaster to concrete surfaces, and is now engaged in reviewing the general specifications for gypsum plaster. It cooperated in the initiation of the work of the Building Code Committee of the Department of Commerce. It is represented on the A. S. T. M. committee on gypsum, the A. E. S. C. sectional committee on specifications for fire tests of materials and construction, and the National Fire Protection Association committee on building construction.

Hardwood Manufacturers Institute, J. H. Townshend, executive vice president, 1339 Bank of Commerce Building, Memphis, Tenn. This organization is officially represented on the National Committee on Wood Utilization, the Central Committee on Lumber Standards, and the consulting committee on lumber standards. In cooperation with the National Hardwood Lumber Association it has formulated grading rules covering specifications for the measurement and inspection of hardwood lumber.

Heating and Piping Contractors National Association, Henry B. Gombers, secretary, 50 Union Square East, New York, N. Y. Two special committees and one standing committee are carrying on work of standardization for the association. The special boiler output committee has been appointed by the president, to formulate a

method of determining the output of boilers. Through conferences with boiler manufacturers it has already developed a standard method, and is now engaged in compiling data to permit the selection of the proper boiler for any chosen installation. The special committee on certified heating has been appointed by the president to develop a standard method of procedure for use with the "certified heating" plan, according to which the purchaser is assured that his heating plant has been designed and installed in compliance with recognized engineering standards. This plan is now being applied in Boston, Buffalo, Chicago, Cleveland, Denver, Los Angeles, Memphis, Philadelphia, and St. Louis, and the movement is spreading rapidly. The association's standing committee on standardization, appointed by the president, has authority, with the consent of the board of directors, to undertake such standardization projects as will be of benefit to the heating and piping industry, and to coordinate the work of other committees of the association wherever it touches the field of standardization. After conference with representatives of other interested organizations each proposed standard developed by the committee is submitted to the board of directors first in tentative form, and later, after other interests involved have been consulted, the revised standard is submitted to the board for adoption. This committee is now engaged on the standardization of pipe sizes for different installations, and the calculation of exposure factors for various cities. The list of cities for which exposure factors have been determined was extended materially during 1926. The committee developed standard roughing-in dimensions for radiator supply valves which became effective on January 1, 1926. In cooperation with the research laboratory of the American Society of Heating and Ventilating Engineers and the United States Department of Commerce, this committee was able to bring about the elimination of the steam type of radiator, as it was found that the water type of radiation was just as efficient on steam heating as the steam type of radiator. The association is joint sponsor, with the American Society of Mechanical Engineers and the Manufacturers Standardization Society of the Valve and Fittings Industry, for the sectional committee on pipe flanges and fittings, which is functioning under under the rules of procedure of the American Engineering Standards Committee. It is represented on three additional sectional committees functioning under the A. E. S. C. procedure.

Hollow Building Tile Association, The, J. S. Sleeper, secretary, Conway Building, Chicago, Ill. For more than seven years this association has been engaged in standardization and simplification work of hollow building tiles. In cooperation with the National Bureau of Standards, the association has conducted research relating to hollow tile and its uses and research on manufacturing problems.

It has conducted a series of tests on the following subjects to determine the quality and uses of hollow tile: Fire resistance, strength of individual units of tile and their related strength in the wall sound travel through hollow tile walls, insulating value of hollow tile, research on mortar values, resistance of hollow building tile to weather conditions, absorption tests, adhesion of mortars and stuccos, effect of grind on both strength and fire resistance, adding grog to improve fire resistance, fire tests on plastered walls, size of units in fire tests to determine variations in different size units, expansion determinations, and chemical and mineralogical analyses of a large number of clays to determine the causes of failure in some tile. Tests have also been conducted on the addition of sawdust and its effect, the effect of varying sizes of fillets, the effect of design on fire resistance and strength, fusing points of typical clays, etc. The results of these research tests are embodied in the reports and publications issued by the association. Three research associates are maintained by this association at the National Bureau of Standards doing research work on the fire resistance of hollow tile walls, acoustics of hollow tile walls, and adhesion of plasters to hollow tile backings. The association has arranged with testing laboratories throughout the country to make tests on hollow building tile in accordance with the standard method of testing recommended by the National Bureau of Standards. The association has assisted in the work of the building code committee of the Department of Commerce on the following reports: Recommended minimum requirements for small dwelling construction, and recommended minimum requirements for masonry wall construction. Its standards committee has been active in the formulation and adoption of minimum standard sizes for hollow building tile contained in the division of simplified practice recommendation for this commodity. The association has cooperated with committees of the American Society for Testing Materials in the formulation of standards for tile. It is officially represented on the sectional committee on specifications for fire tests of materials and construction, functioning under the rules of procedure of the American Engineering Standards Committee.

Horological Institute of America, Paul Moore, secretary, care of National Research Council, Washington, D. C. Among the stated objects of the institute, which was organized by the National Research Council, are the development of standards for horological schools and the establishment of a system of varying attainments for watchmakers. It gives examinations to watchmakers in both the theory and practice of watch repairing, and grants certificates to those passing its requirements. The institute maintains a research associate at the National Bureau of Standards doing research work on the certification of watchmakers.

Illuminating Engineering Society, L. H. Graves, general secretary, 29 West Thirty-ninth Street, New York, N. Y. The standardization work of the society is carried on by four committees which have been placed on a representative basis with members nominated by and officially representing various other organizations, and now function as sectional committees under the rules of procedure of the American Engineering Standards Committee, with the society serving as sponsor or joint sponsor, as follows: Code of lighting factories, mills, and other work places; code of lighting school buildings (with the American Institute of Architects); automobile headlighting specifications—laboratory tests for approval of electric headlighting devices for motor vehicles (with the Society of Automotive Engineers); and illuminating engineering nomenclature and photometric standards. The society is represented on four additional sectional committees functioning under A. E. S. C. procedure.

Institute of American Meat Packers, W. W. Woods, executive vice president, 509 South Wabash Avenue, Chicago, Ill. All standardization and simplification activities of the institute are conducted through the committee on packinghouse practice and research. As a result of the original work done by this committee in the elimination of unnecessary sizes and styles of inner containers such as lard tins, etc., a subcommittee on standardization was appointed to continue the work of standardization of other equipment and supplies. The following commodities have already been standardized: Lard cans; sausage, lard, and sliced bacon cartons; cheesecloth and muslin; paper; nailed wooden crates and boxes; hand trucks; beef and pork trolleys; woodenware and cooperage. The committee is now working on the following items: Twines, brushes, and autotruck bodies. The institute conducts a central research laboratory which is supported by the member companies. Its department of scientific research is now engaged in problems concerning, among other subjects, the curing and conservation of meats.

Institute of Paint and Varnish Research, Henry A. Gardner, director of laboratory, 2201 New York Avenue NW., Washington, D. C. The institute works in close harmony with the National Bureau of Standards on research problems, and cooperates with the Federal Specifications Board in preparing specifications for paint and varnish.

Institute of Radio Engineers, Dr. Alfred N. Goldsmith, secretary, 37 West Thirty-ninth Street, New York, N. Y. Standardization represents an important part of the activities of the institute which has formulated, adopted, and promulgated standard definitions of terms and standard graphical symbols used in radio engineering. The institute's committee on standardization is undertaking the formulation of standard methods of testing radio apparatus in order

to determine the important characteristics of such devices, particularly those used in radio-broadcast reception. The committee is conducting its work through five subcommittees covering the following subjects: Vacuum tubes, circuit elements, receiving sets, electroacoustic devices, and power supply. The members of the committee on standardization are appointed by the president. The committee works by correspondence and through discussions at meetings of the committee and its subcommittees. The standards which it recommends are submitted to the board of directors by which final action is taken in behalf of the institute. The institute is joint sponsor with the American Institute of Electrical Engineers for a sectional committee on radio, and is officially represented on three additional sectional committees functioning under A. E. S. C. procedure. It is a member of the National Fire Protection Association.

International Apple Shippers' Association, R. G. Phillips, secretary, 1108 Mercantile Building, Rochester, N. Y. This association has for many years taken a very active part in standardization matters relating to fresh fruits and vegetables. It was particularly active in connection with the enactment of the United States apple grading law approved August, 1912, the national standard barrel law in effect July 1, 1916, the New York State apple grading law enacted in 1915, and other pioneer measures relating to standardization of fruits and vegetables. Subsequently the association has closely followed and interested itself in all Federal and State legislation of this character. It has furthermore rendered effective service in the general standardization movement by giving publicity in special pamphlet form to the important laws of the State and Federal Governments, relating to grades, marks, packing, packages, and standards of fruits and vegetables, and to the Federal food and drugs act.

International Association of Electrotypers of America, H. G. Guiteras, field secretary, Leader Building, Cleveland, Ohio. Two of the main activities of this association lead directly to standardization. One is formulating for the industry a uniform method of determining the cost of producing electrotypes, and the other is conducting research work to establish the best methods of making electrotypes. The association maintains a research associate at the National Bureau of Standards doing research work on electrotyping problems. A cost accountant is employed to install the cost system and carry on a cost service for members of the association and the industry in general.

International Association of Industrial Accident Boards and Commissions, Ethelbert Stewart, secretary, Bureau of Labor Statistics, Washington, D. C. Standardization in the safety code field represents an important part of the activities of this association. It

is joint sponsor for four sectional committees functioning under the rules of procedure of the American Engineering Standards Committee, as follows: Safety code for the use, care, and protection of abrasive wheels (with the Grinding Wheel Manufacturers Association of the United States and Canada); safety code for mechanical power transmission apparatus (with the American Society of Mechanical Engineers and the National Bureau of Casualty and Surety Underwriters); safety code for rubber machinery (with the National Safety Council); safety code for woodworking plants (with the National Bureau of Casualty and Surety Underwriters). It is represented on 21 additional sectional committees functioning under A. E. S. C. procedure.

International Association of Milk Dealers, R. E. Little, executive secretary, 139 North Clark Street, Chicago, Ill. Standardization and simplification are important activities of this association. Its committee on standardization of equipment consists of five members appointed by the president and approved by the board of directors. The function of this committee is to cooperate with similar committees from the manufacturers' organizations and the Department of Commerce in the work of standardization and simplification of milk-plant equipment. The committee's activities are reported to the annual convention in the form of recommendations. In the past year the association adopted the committee's recommendation for the standardization of sanitary thermometer connections for various size Pasteurizing vats and tanks. In cooperation with similar committees representing the Allied States Creameries Association and the National Association of Ice Cream Manufacturers, the committee on standardization of equipment has prepared specifications for standard interchangeable sanitary pipe fittings which were adopted by the association. All sanitary pipe and fittings used in the milk plants are now interchangeable. The committee cooperated with committees of bottle manufacturers and the Department of Commerce in the elimination of various heights of bottles and cap seats and the establishment of standard sizes. The committee is now engaged in the work of revising the simplified practice recommendation for milk and cream bottles with a view toward securing a further reduction in types and looking toward a standard bottle in each of the respective heights.

Interstate Cotton Seed Crushers' Association, George H. Bennett, secretary, 914 Santa Fe Building, Dallas, Tex. The association has adopted definitions of grade and quality of cottonseed, cottonseed oil, peanut, soya bean, and coconut products, and issued rules governing the sampling and sale of these commodities. In cooperation with the American Oil Chemists' Society it has formulated methods of chemical analysis. To render these definitions, rules,

and analyses effective any member of the association found guilty of misbranding or adulteration is dismissed from membership. Action is now being taken by the refiners' division of the association looking to a substantial reduction in the number of containers used for vegetable compound.

Laundryowners National Association of the United States and Canada, W. E. Fitch, general manager, Drawer 202, La Salle, Ill. Although the association has no distinct standardization committee, its departments of research, engineering, and uniform cost accounting carry on work having a direct bearing upon standardization. It has evolved a uniform system of cost accounting now in general use among its membership which represents about 70 per cent of the volume of laundry business in the United States. The association compiles operating cost data, and distributes the significant information to such members as have adopted the uniform system of accounting. A manual of standard practice in accounting has been published for the benefit of the industry. The association has also published a manual of standard practice for the power laundry washroom, the development of which is attributable to the fellowship of three textile experts maintained by the association at the Mellon Institute for Industrial Research. In this work the association has received the cooperation of the Converters Association of New York, the Lowell Textile School, the National Association of Dyers and Cleaners, the National Association of Finishers of Cotton Fabrics, and the National Bureau of Standards. The association is cooperating with the Good Housekeeping Institute, the National Better Business Bureau, Home Economics Department of Columbia University, and Women's Wear and Daily News Record in the task of establishing standards of fast color. Through its department of engineering the association is undertaking to standardize building construction, plant layouts, ventilation, heating, and lighting. In the American Institute of Laundering (Inc.), maintained by the Laundryowners' National Association of the United States and Canada at Joliet, Ill., practical applications are made of research findings developed at the Mellon Institute and by the department of engineering and cost accounting. A standard ratio of costs is being developed in conjunction with the engineering and uniform accounting departments. The association is joint sponsor, with the Association of Governmental Labor Officials of the United States and Canada and the National Association of Mutual Casualty Companies, for the sectional committee on safety code for laundries functioning under the rules of procedure of the American Engineering Standards Committee.

Leather Belting Exchange, Louis W. Arny, secretary, 119 South Fourth Street, Philadelphia, Pa. This association collaborated in the preparation of, and has officially approved, the specifications for

leather belting promulgated by the Federal Specifications Board. It maintains at Cornell University a research laboratory in order to develop better methods for manufacturing leather belting.

Machinery Builders' Society, W. C. Fulmer, secretary, 50 Church Street, New York, N. Y. The several sections of the society are active in standardization work. They have formulated standard rules of obsolescence covering patterns, jigs, and fixtures; standard practice of marking patterns; and a standard accounting and cost system. The hydraulic section developed a testing code for hydraulic turbines which formed the basis for the A. S. M. E. code. The marine section prepared specifications for bronze propellers which have been formally approved by the society.

Manufacturers Standardization Society of the Valve and Fittings Industry, Albert C. Taylor, general secretary, 103 Park Avenue, New York, N. Y. Organized for the purpose of formulating and promulgating standards satisfactory to the valve and fittings industry, this society issues a series of "standard practices" relating to the minimum permissible grade or quality of valves and fittings which have been adopted by the society. It is serving as joint sponsor, with the American Society of Mechanical Engineers and the Heating and Piping Contractors National Association, for a sectional committee on pipe flanges and fittings and is officially represented on four additional sectional committees functioning under A. E. S. C. procedure.

Manufacturing Chemists' Association of the United States, John I. Tierney, secretary, Investment Building, Fifteenth and K Streets, NW., Washington, D. C. For more than 50 years this association has been active in the movement for standardization of practice and equipment in the chemical industry. It has adopted standard tables for aqua ammonia, hydrochloric acid, nitric acid, sulphuric acid, and zinc chloride. In cooperation with representatives of container manufacturers and the railroads, its standing committees have developed standards for containers which have been incorporated in the official specifications of the Interstate Commerce Commission. These committees have completed or are now at work on specifications for carboys, steel drums and tank cars, and packages for the transportation of powdered insecticides and other poisonous articles. In cooperation with the American Chemical Society and the manufacturers of chemical apparatus a committee of the association prepares specifications for graduates, thermometers, and other laboratory apparatus. A committee is now cooperating with representatives of manufacturers in the development of standards for earthenware apparatus.

Maple Flooring Manufacturers Association, George W. Keehn, secretary, Stock Exchange Building, Chicago, Ill. Among the stated

purposes of the association are the establishment and enforcement of uniform grades and standards, and the making of the association trade-mark the symbol of excellence in methods and materials. Member firms are permitted to use the association's trade-mark on maple, beech, or birch flooring which is standardized and guaranteed by the association when passed upon by the association's official inspector.

Milling Cutter Society, The, Herbert S. Blake, secretary, 120 Broadway, New York, N. Y. The standing committee on simplification and standardization is actively engaged in the task of eliminating from catalogue lists, sizes and styles of milling cutters which the trade no longer demands, and is establishing proper standard basic mechanical sizes of these tools to be listed in revised catalogues. The membership acts upon the recommendations of the committee submitted at general meetings of the society.

Mine Inspectors Institute, Martin Bolt, secretary, department of mines, Springfield, Ill. The institute is interested in all phases of standardization relating to the selection, installation, or use of equipment in mines. It is officially represented on the mining standardization correlating committee. The institute is serving as sponsor for a sectional committee on safety code for mine explosives and is represented on 11 additional sectional committees, functioning under A. E. S. C. procedure, dealing with both coal and metal mining equipment and the safe operation thereof.

National Association of Brass Manufacturers, William M. Webster, commissioner, 139 North Clark Street, Chicago, Ill. The association organized a special committee on Government plumbing fixtures specifications which cooperated with the Federal Specifications Board in the preparation of the United States Government master specification for plumbing fixtures for land use. Its standardization committee is actively engaged in formulating standards to be included in its book of standards.

National Association of Cotton Manufacturers, Russell T. Fisher, secretary, 80 Federal Street, Boston, Mass. (See National Council of American Cotton Manufacturers.)

National Association of Dyers and Cleaners, Ivan M. Tull, general manager, Mills Building, Suite 807, Washington, D. C. Work along standardization lines is carried on by research associates maintained by this organization at the National Bureau of Standards under the direction of a research committee appointed by the president. The recommendations and reports of this committee are submitted to the members of the association at annual conventions. In 1926 the association with the aid of experienced dry cleaners prepared and published a book entitled, "Some Standard Practices for Cleansing." It is now engaged in the preparation of a testing method for

rating fabrics as to maintenance requirements in cleansing by the commercial dry cleaner.

National Association of Farm Equipment Manufacturers, H. J. Sameit, secretary, 608 South Dearborn Street, Chicago, Ill. One of the chief functions of this organization is the work of simplification and standardization of farm machinery and equipment. The association represents many different lines of manufacture and because of this diversity the organization has been divided into 11 different departments—9 trade departments and 2 general departments. The trade departments, operating under their own by-laws and having their own officers, perform the work of standardization of products and elimination of unnecessary styles and varieties. One of these divisions, the plow and tillage implement department, issued a "book of standards" in May, 1926, summarizing the eliminations made by that branch of the industry since 1914, which cover the following implements: Walking plows, riding moldboard plows, corn planters, tractor moldboard plows, stalk cutters, peg-tooth harrows, disk harrows, land rollers, spring-tooth harrows, drills, seeders, cultivators, and drill and seeder attachments (disk harrows). The committee on wood materials conservation of the farm-wagon department of the association has compiled and published a pamphlet on specifications and grading, and inspection rules for wagon material and wagon stock. These rules have been adopted jointly by this association and the National Hardwood Lumber Association. At the association's request, the division of simplified practice called a conference of manufacturers of bolts and nuts for farm equipment. The result of this conference was the adoption of a certain limited number of sizes and types of bolts and nuts which are contained in simplified practice recommendation for plow bolts.

National Association of Glue Manufacturers, H. B. Sweatt, secretary, 1457 Broadway, New York, N. Y. Methods of test and technical problems of interest to the association are investigated by the association's technical division, which is composed of one representative from each member firm. The division has formulated and published standard methods for testing the viscosity and jelly strength of glue. The division directs the activities of two research fellows, one at the National Bureau of Standards and the other at Miner Labratories, Chicago, Ill.

National Association of Hosiery and Underwear Manufacturers, J. N. McCullaugh, national secretary, 334 Fourth Avenue, New York, N. Y. Standardization and research form the major part of the work of this association. It has adopted standard methods for measuring stockings; standard sizes for hosiery boxes; and standard lengths for hosiery for men, women, children, and infants. The association maintains a research associate at the National Bureau of

36316—27——24

Standards who has completed work on seven-eighth's length hosiery, and is now inaugurating research work on standardization of twist for all carded and combed yarns used for hosiery and underwear, and on moisture and oil content for rayon yarns.

National Association of Ice Cream Manufacturers, Fred Rasmussen, secretary, 416 Telegraph Building, Harrisburg, Pa. Standardization work of this association is carried on by the committee on standardization of equipment. This committee is formulating standards for ice-cream cans. In cooperation with similar committees of the Allied States Creameries Association and the International Association of Milk Dealers, it has prepared specifications for a standard interchangeable sanitary fitting which have been accepted and approved by this association. A standard cost-accounting system has been developed by the association.

National Association of Manufacturers of Heating and Cooking Appliances, Allen W. Williams, secretary, Columbus, Ohio. This association is interested in standardization from the point of view of both simplification and safety. It has organized a gas appliance safety committee to cooperate in the preparation of a gas-safety code, and a committee on simplified practice to deal with coal stoves and ranges and gas ranges. Although appointed by the president of the association the last-mentioned committee is composed of both members and nonmembers, and serves as the point of contact between the stove industry and the division of simplified practice. The association is officially represented on the sectional committee on bolt, nut, and rivet proportions functioning under A. E. S. C. procedure.

National Association of Marble Dealers, Victor Mosel, secretary, 648 Rockefeller Building, Cleveland, Ohio. This association has not as yet formulated any standards or specifications. It does, however, maintain a research associate at the National Bureau of Standards doing research work on the use and care of marble for interior installations.

National Association of Mutual Casualty Companies, J. M. Eaton, secretary, 730 Fifth Avenue, New York, N. Y. Standardization in the safety code field forms an important part of the work of this association which is officially represented on the safety code correlating committee. It is joint sponsor for the sectional committee on safety code for laundries (with the Association of Governmental Labor Officials of the United States and Canada and the Laundryowners National Association), and is represented on 24 additional sectional committees functioning under A. E. S. C. procedure.

National Association of Purchasing Agents (Inc.), W. L. Chandler, secretary, Woolworth Building, New York, N. Y. Standardization and simplification constitute important activities of this organization. It brought together various bodies interested in standardizing cata-

logue sizes and developed a standard size. It initiated movements for the adoption of a national standard invoice form and the promulgation of iron and steel scrap specifications, which have been widely accepted, and made simplified practice recommendations by the division of simplified practice. The association also cooperated in the formulation of simplified practice recommendations for paper sizes, catalogue sizes, and standard warehouse forms, and in the promulgation of standard contracts for coal and other fuels. In cooperation with the American Engineering Standards Committee, the American Society for Testing Materials, and other national organizations, it is actively engaged in work on pattern equipment standardization, naval stores, gear standardization, and other like movements. The association is represented on the following committees of the United States Department of Commerce through which most of its work on standardization and simplification is done: The division of simplified practice planning committee, National Committee on Metals Utilization, National Committee on Wood Utilization, committee on simplification of desk sizes, consulting committee on lumber standards, and the committee on simplification of paint and varnish brushes. It is represented on three sectional committees functioning under the rules of procedure of the A. E. S. C. The association was officially represented on the advisory board which cooperated with the United States Department of Commerce in the preparation of the National Directory of Commodity Specifications.

National Association of Sheet and Tin Plate Manufacturers, Walter W. Lower, secretary-treasurer, Oliver Building, Pittsburgh, Pa. This organization was one of the first to formulate specifications for steel scrap. It has also prepared a list of sheet mill tolerances containing permissible variations in the furnishing of sheet steel. Valuable assistance was rendered by this association in the compilation of material for the division of simplified practice recommendation for sheet steel. Work is going forward on the standardization of depreciation for the sheet-steel industry in cooperation with the United States Treasury Department.

National Association of Sheet Metal Contractors of the United States, W. C. Markle, secretary, 334 Fourth Avenue, Pittsburgh, Pa. A committee of the association has been compiling specifications for every branch of sheet metal work in building construction, including warm air furnaces, ventilating systems, metal window frames and sash, metal ceilings, and various kinds of roofing. The association has been particularly active in making effective the simplified practice recommendations relating to the weights and thicknesses of terneplate, and the elimination of lighter than No. 28 gauge sheets for roofing, eaves trough, and conductor.

National Association of Steel Furniture Manufacturers, J. D. M. Phillips, secretary, Union Trust Building, Cleveland, Ohio. This association has formulated specifications for various kinds of steel furniture, including bookcases, desks, horizontal and vertical filing cases, wastebaskets, lockers, tables, and cupboards. It has cooperated in the establishment of the standards for safes complying with the requirements of the Underwriters' Laboratories label service.

National Association of Waste Material Dealers, C. M. Haskins, secretary, Times Building, New York, N. Y. This association has been a pioneer in establishing standard classifications for waste materials, including metals, rubber, paper, and cotton and woolen rags. In drawing up standard classifications the association follows its established plan of consulting the associations representing consumers of such material.

National Association of Wooden Box Manufacturers, Paul L. Grady, secretary, 844 Rush Street, Chicago, Ill. This association has been active in promoting scientific research in box construction and standardization of boxes and crates. Many types of packages have already been standardized and many others are being studied with a view to standardization. It has published a book entitled "Wooden Box and Crate Construction," containing detailed information relating to the use of wood in box and crate construction, box design, crate design, box and crate testing, and structure and identification of woods. The book also contains a chapter devoted to box and crate specifications. The association has compiled and issued a technical sheet which deals with the proper construction of boxes, known as the "Nailing Schedule." It is officially represented on the consulting committee on lumber standards.

National Association of Wool Manufacturers, Walter Humphreys, secretary, 80 Federal Street, Boston, Mass. The activities of this association relating to standardization are carried on by a joint committee on research and standardization made up of members of this association, the American Association of Woolen and Worsted Manufacturers, and the National Association of Woolen and Worsted Spinners. Recommendations are submitted to the joint committee before final adoption as the association's standards. A committee of this organization has made a study of the standardization of cost factors.

National Association of Woolen and Worsted Spinners, J. J. Nevins, secretary, 45 East Seventeenth Street, New York, N. Y. The standardization activities of this association are conducted by a joint committee on research and standardization composed of members of this association, the American Association of Woolen and Worsted Manufacturers, and the National Association of Wool Manufacturers. Recommendations of this organization are sub-

mitted to the joint committee before final adoption as the association's standards.

National Automobile Chamber of Commerce, Alfred Reeves, general manager, 366 Madison Avenue, New York, N. Y. This organization has cooperated with the National Bureau of Standards, Society of Automotive Engineers (Inc.), and the American Petroleum Institute in the development of most suitable specifications for motor fuels. It is officially represented on the sectional committees on colors for traffic signals and safety code for automobile brakes and brake testing, functioning under the rules of procedure of the American Engineering Standards Committee. It is also cooperating with the United States Department of Commerce by representation on the National Committee on Metals Utilization.

National Board of Fire Underwriters, W. E. Mallalieu, general manager, 85 John Street, New York, N. Y. The standardization activities of the board are conducted under the direction of its standing committee on fire prevention and engineering standards, the membership of which is appointed by the president of the board. This committee has authority to adopt, subject to approval by the executive committee, regulations which are later printed and issued by the National Board of Fire Underwriters. Practically all of the existing regulations have been recommended by the National Fire Protection Association, and were prepared by the various technical committees of that association, the membership of which committees includes in all cases a representative from the engineering department of the board. During 1926 the committee has given special consideration to specifications for the construction of automobile tank trucks, regulations on signaling installations, oil-storage rooms and buildings, pyroxylin finishes, fusion gas welding, the use of compressed gases for lighting, heating, and cooking, and dry-cleaning establishments. In the standardization of fire-hose couplings the board has been very active, and to date in about 1,700 cities and towns standard couplings are used. The regulations of the board for the installation of hazardous and protective devices as recommended by the National Fire Protection Association have been issued in 42 pamphlets. Work is now going forward on the preparation for issue of nine additional pamphlets on: Municipal fire alarm systems; protective signaling systems; dust explosions in starch factories; gasoline vapor gas machines, lamps, and systems; gravity and pressure tanks; foam extinguishing systems; dip tanks; spraying operations; rotary and centrifugal fire pumps. The board is joint sponsor for two sectional committees functioning under the rules of procedure of the American Engineering Standards Committee, as follows: Screw threads for fire-hose couplings (with the American Society of Mechanical Engineers and the American Water Works

Association), insulated wires and cables for other than telephone and telegraph use (with nine other organizations). The board is represented on three additional sectional committees functioning under A. E. S. C. procedure. As a member of the fire-protection group, the board is joint sponsor for specifications for fire tests of materials and construction (with the American Society for Testing Materials and the National Bureau of Standards) and specifications for rubber-lined fire hose (with the American Society for Testing Materials). (See the Underwriters' Laboratories.)

National Building Granite Quarries Association (Inc.), H. H. Sherman, secretary, 31 State Street, Boston, Mass. This association has adopted a uniform proposal blank for use by all members in submitting estimates. This proposal form serves to standardize the terms and conditions embodied in the estimates. It has also adopted uniform contract forms which are recommended for general use on contracts for granite work. These contract forms embody the terms and conditions upon which the proposals are based. The association has formulated complete granite specifications, which include standards of workmanship, requirements, and other essential details.

National Bureau of Casualty and Surety Underwriters, H. P. Stellwagen, secretary, 120 West Forty-second Street, New York, N. Y. The bureau, which has been intimately associated with the development of industrial safety codes as the basis for the application of schedule rating, is primarily and principally interested in standardization in the field of safety codes. It is sponsor or joint sponsor for seven sectional committees functioning under the rules of procedure of the American Engineering Standards Committee, for formulating safety codes for the following subjects: Machine tools (with the National Machine Tool Builders Association); mechanical power transmission apparatus (with the American Society of Mechanical Engineers and the International Association of Industrial Accident Boards and Commissions); conveyors and conveying machinery (with the American Society of Mechanical Engineers); mechanical power control (with the American Society of Mechanical Engineers); woodworking plants (with the International Association of Industrial Accident Boards and Commissions); tanneries; amusement parks (with the National Association of Amusement Parks). The bureau is represented on 31 additional sectional committees functioning under A. E. S. C. procedure. The other work of the bureau has to do with standardization in a still more general sense, particularly the standardization of rating methods and practice for the various forms of casualty insurance.

National Canners Association, Frank E. Gorrell, secretary, 1739 H Street NW., Washington, D. C. Standardization committees

appointed by this association are working in cooperation with the joint committee on definitions and standards of the United States Department of Agriculture on standard grades of various food products. The conference committee with wholesale grocers confers with like committees representing various associations of wholesale grocers on matters of common interest regarding standard forms of contracts. The association has developed a standard classification of accounts for members of the canning industry. Special attention is being given by the association to proper trade terms in connection with labeling. It cooperates with Federal and State officials in the enforcement of uniform regulations pertaining to proper and intelligent labeling.

National Coal Association, Harry L. Gandy, executive secretary, Southern Building, Fifteenth and H Streets NW., Washington, D. C. All standardization work of the association is conducted under the supervision of the mining standardization correlating committee. The association is officially represented on not only this committee but also 14 sectional committees functioning under the procedure of the American Engineering Standards Committee.

National Committee on Metals Utilization, W. Chattin Wetherill, director, United States Department of Commerce Building, Washington, D. C. This committee was organized in 1926 for the purpose of carrying the principles of simplified practice more deeply into the metals-using field, unifying specifications, discontinuing certain trade practices, and acting as a clearing house in bringing together manufacturers, distributers, and users of the various industries. The ultimate aim of the committee is to awaken a nation-wide interest in the need for eliminating industrial waste, and to stimulate mass action in applying corrective measures. It is now composed of 22 member groups constituting an impartial body working in close cooperation with official and private agencies, and representing all branches of industry and trade interested in closer metal utilization, better manufacturing, distributing, and metal-using practices. The following organizations are officially represented on the committee: The American Electric Railway Association; American Engineering Council; American Engineering Standards Committee; American Federation of Labor; American Foundrymen's Association; American Institute of Electrical Engineers; American Iron and Steel Institute; American Railway Association; American Society for Testing Materials; American Society of Mechanical Engineers; American Zinc Institute (Inc.); Chamber of Commerce of the United States of America; division of simplified practice, United States Department of Commerce; Hollow Metal Door and Trim Manufacturers Association; National Association of Farm Equipment Manufacturers; National Association of Manufacturers of the United States; National

Association of Purchasing Agents; National Automobile Chamber of Commerce; National Founders' Association; National Machine Tool Builders Association; National Metal Trades Association; and the National Retail Hardware Association. The committee assisted in the completion of the following recommendations issued by the division of simplified practice: Grinding wheels, sidewalk lights, die head chasers, steel reinforcing spirals, carbon brushes and brush shunts, and wrought-iron and wrought-steel pipe, valves, and fittings. It is assisting in 20 additional projects which are destined for final consideration of all interests, and has accepted 14 definite requests from industry regarding the desirability of instituting surveys of current overdiversification. In the field of simplification the National Committee on Metals Utilization cooperated with the division of simplified practice in the issuance of the classification of iron and steel scrap. A committee appointed by the industry is at present actively engaged in a survey of current practice in specifying grades of steel for reinforced concrete. The committee is cooperating with the foundry industry in its effort to determine whether or not weights of castings should be indicated on blue prints and inquiry forms sent to foundries for estimate. Adequate "hall-marking" of sterling silverware is also under consideration by the committee. The National Committee on Metals Utilization is sponsor or joint sponsor for two standardization projects or sectional committees functioning under the rules of procedure of the American Engineering Standards Committee, as follows: Spiral steel rods for concrete reinforcement, and dimensions of wrought-iron and wrought-steel pipe.

National Committee on Wood Utilization, Axel H. Oxholm, director, United States Department of Commerce Building, Washington, D. C. This committee was organized in 1925 for the purpose of working for closer wood utilization and for better manufacturing, distributing, and wood using practices. The ultimate aim of the committee is to make reforestation commercially feasible through increased utilization of the raw materials. The committee is composed of more than 100 members selected from the branches of industry and trade concerned with the problem of wood utilization. They represent producers, distributers, and consumers of wood and wood products. The following organizations are officially represented on the committee: The American Association of State Highway Officials, American Institute of Architects, American Institute of Mining and Metallurgical Engineers, American Paper and Pulp Association, American Railway Association, American Society of Agricultural Engineers, American Society of Civil Engineers, American Wood Preservers' Association, Associated General Contractors of America, Building Officials' Conference, Chamber of Commerce of the United States of America,

Columbia River Loggers Information Bureau, Council of American Shipbuilders, Furniture Manufacturers' Association of Grand Rapids, Longleaf Yellow Pine Manufacturers Association, National American Wholesale Lumber Association, National Association of Builders' Exchanges, National Association of Purchasing Agents, National Association of Railway Tie Producers, National Association of Real Estate Boards, National Association of Wood Turners, National Automobile Chamber of Commerce, National Grange, National Lumber Manufacturers' Association and its affiliated regional and species associations, National Piano Technicians Association, National Retail Lumber Dealers Association, National Wood Chemical Association, New Hampshire Lumbermen's Association, Pine Institute of America, Plywood Manufacturers Association, United States League of Local Building and Loan Associations, and the West Coast Lumber Trade Extension Bureau. The membership has been divided into various groups representing loggers and lumbermen, manufacturers of small-dimension stock, container producers, plywood and veneer manufacturers, wood chemical producers, paper and pulp manufacturers, lumber distributers, and construction industries. These groups outline the program of work to be transacted under the auspices of the committee. The promotion of American lumber standards and the development of efficient uses for short lengths (lumber less than 8 feet long), and for odd lengths and widths, together with increased uses for end-matched softwood lumber, are parts of the committee's program. The container group is at present conducting an investigation of the best methods of packing and improved container construction in the foreign field. The data compiled will be consolidated with similar information obtained in this country. The purpose of this investigation and findings is to arouse among the consumers of containers an interest in scientific container construction, so as to save as much lumber as possible and, at the same time, decrease the weight of the containers without impairing their usefulness and strength. The committee has been the medium of bringing together manufacturers, distributers, and consumers. In many cases practically no effective contact existed between manufacturers and consumers. Manufacturers were not informed of the consumers' needs and the consumers had no knowledge of the problems confronting the manufacturers, and as a result lumber and wood products as shipped from the producing plants were often manufactured with little regard for ultimate uses. Such groups as those representing furniture, radio equipment, automobiles, and many others are now in touch with lumber producers through the committee's efforts and a considerable amount of standardization of the requirements of consumers is under way. This work has been accomplished through the cooperation of the division

of simplified practice. Frequently the committee has been called upon by Government agencies and business institutions to give impartial advice in regard to the utilization of wood and wood products. It cooperates with the National Bureau of Standards of the Department of Commerce and the Forest Products Laboratory of the Forest Service, United States Department of Agriculture, concerning problems of wood utilization. The work of the committee lies largely in the direction of applying the results of scientific research with respect to the proper utilization of wood and wood products, and of securing the cooperation of industry in putting these recommendations into effect. It has prepared a report on softwood distillations, which will be published shortly. The report represents the best practices in the United States and abroad, with particular attention to the possible adaptation of foreign methods to American conditions. Publications containing the results of the work of the committee are now being prepared; a report on "The Marketing of Short-length Lumber" has already appeared.

National Council of American Cotton Manufacturers, W. McLaurine, joint secretary, Charlotte, N. C.; Russell T. Fisher, joint secretary, 80 Federal Street, Boston, Mass. This organization has established no standards or specifications. However, its constituent members, the American Cotton Manufacturers' Association and the National Association of Cotton Manufacturers, have organized a joint committee on standardization of specifications, composed of three members from each association appointed by the presidents. This committee receives proposed specifications from the Federal Specifications Board and distributes copies to manufacturers interested in the particular articles covered thereby. After criticisms have been compiled, the specifications are revised in accordance with the majority opinion and submitted for the information of the Federal Specifications Board.

National Crushed Stone Association, A. P. Sandles, secretary, 405 Hartman Building, Columbus, Ohio. Standardization activities of the association are conducted in cooperation with the American Society for Testing Materials or under the auspices of the American Engineering Standards Committee. It is officially represented on four sectional committees functioning under A. E. S. C. procedure.

National District Heating Association, D. L. Gaskill, executive secretary, 112 West Fourth Street, Greenville, Ohio. This association was organized in 1909 and was created to gather data and information along the line of district heating, as well as heating in general. It has formulated rules for computing the area of radiating surfaces required for heating buildings which have been formally approved by the association. It has also simplified, and made recommendations in relation to, underground installation and the

conveying of steam over considerable distances for heating buildings. It has conducted studies relating to the resistance of materials to temperatures.

National Education Association, J. W. Crabtree, secretary, 1201 Sixteenth Street, NW., Washington, D. C. One of the most important activities of this association has been the publication of a book on the planning and construction of schoolhouse buildings. This book, which was prepared by its committee on standardization of schoolhouse planning and construction, in cooperation with the American Society of Heating and Ventilating Engineers, American Specification Institute, National Association of Public School Business Officials, and the National Fire Protection Association, is entitled "School House Planning." In it are set forth the steps necessary to plan and construct a school building, such as appointment of investigating committee, survey of needs and existing accommodations, determination of number of pupils to be accommodated by proposed building, appointment of building committee, selection of architect, determination of schedule of rooms, selection of site, preparation and approval of plans and specifications, securing bids, letting contracts, and supervision of construction and equipment. Although the association has no authority to compel the use of the book, it is being utilized voluntarily by school boards throughout the country, and serves to establish uniform standards for the schools.

National Electric Light Association, Paul S. Clapp, managing director, 29 West Thirty-ninth Street, New York, N. Y. Although the association does not formally adopt standard specifications its committees formulate drafts of specifications which are offered to the membership as recommended practices. Among the committees that have been active in the work are the following technical national committees: Accident prevention, electrical apparatus, hydraulic power, inductive coordination, meters, overhead systems, prime movers and underground systems. These committees are appointed by the president with the approval of the national executive committee and submit their reports at the annual convention of the association. The association cooperates in the activities of the division of simplified practice of the Department of Commerce, with the standards committees of various American societies and with the International Electrotechnical Commission. It is joint sponsor (with four other societies) for studies of boiler feed water problems. It is joint sponsor for two sectional committees functioning under the rules of procedure of the American Engineering Standards Committee, as follows: Insulated wires and cables for other than telephone and telegraph use (with nine other organizations); rules for electricity meters (Code for Electricity Meters) (with the Association of Edison Illuminating Companies and the National Bureau

of Standards). As a member of the electric light and power group it is sponsor for a sectional committee on miscellaneous line materials, and is represented on 26 additional sectional committees functioning under the A. E. S. C. procedure. During 1926 the association set up a new committee on codes and standards charged with the duty of formulating principles and practices in the field of standardization.

National Electrical Manufacturers Association, S. N. Clarkson, executive secretary, 30 East Forty-second Street, New York, N. Y. This association has been formed by the merging of the Associated Manufacturers of Electrical Supplies, Electrical Manufacturers' Council, and the Electric Power Club, the first of which has become the supply division and the last named the apparatus division. The membership of these divisions and the radio division is divided into working sections, each of which embraces all member companies who manufacture a particular class of product. The standards committee of the association, appointed by the board of governors, correlates the development of all its technical standardization, in addition to correlating and supervising proposed simplification affecting products coming within the scope of the association's activities. Action by the standards committee on all standardization rules constitutes formal adoption or rejection by the association, unless an interested member appeals to the board of governors. Conference committees have been established in cooperation with the American Institute of Electrical Engineers, Association of Iron and Steel Electrical Engineers, Association of Railroad Electrical Engineers, Compressed Air Society, Electrical Safety Conference, Hydraulic Society, International Electrotechnical Commission, Mutual Fire Prevention Bureau, National Association of Fan Manufacturers, National Association of Oil Burner Manufacturers, National Electric Light Association, National Fire Prevention Association, National Machine Tool Builders Association, Refrigerating Machinery Association, Society of Automotive Engineers (Inc.), Underwriters' Laboratories, United States Department of Commerce, and the United States War Department. The association is sponsor, or joint sponsor, for the following sectional committees functioning under the rules of procedure of the American Engineering Standards Committee: Standards for insulated wires and cables for other than telephone and telegraph uses (with nine other organizations), standards for switch boxes and outlet boxes (with the American Institute of Electrical Engineers), standards for power-line insulators for voltages exceeding 750 (with the American Institute of Electrical Engineers), standards for industrial control apparatus (with the American Institute of Electrical Engineers), and standard terminal markings for electrical apparatus. The association is also represented on some 30 additional sectional committees functioning under the A. E. S. C.

procedure. The association has issued and keeps under constant revision the following publications covering standards for the manufacture, performance, and test of electrical apparatus and supplies, as well as instructions for their proper installations, operation, and care: Handbook of Standards (supply division), Handbook of Standards (apparatus division), Power Switching Equipment Handbook, Transformer Standards, Transformer Instructions, Motor and Generator Handbook, Motor and Control Instructions, Control Handbook, Building Equipment Control Specifications, Terminal Markings for Electrical Apparatus, and Selection d. c. Motors for Ventilating Fans.

National Federation of Construction Industries, W. S. Hays, secretary, Drexel Building, Philadelphia, Pa. Organized to promote closer cooperative relations between producers, manufacturers, distributers, contractors, architects, engineers, realtors, financiers, and other construction interests, the federation assisted during its active years, and, through the personal efforts of members of its standardization committee and officers, is constantly fostering the development and adoption of standards by its member establishments and associations in the construction industry. Although it has not formally adopted any standards, it is officially represented on four sectional committees functioning under A. E. S. C. procedure.

National Fence Manufacturers Institute, C. M. Best, secretary, 229 Henry W. Oliver Building, Pittsburgh, Pa. The institute has organized a standards committee to make recommendations concerning standardization activities of interest to the institute membership. It inaugurated the movement which resulted in the formulation of the simplified practice recommendation relating to woven-wire fencing which has been adopted by the industry.

National Fertilizer Association, Charles J. Brand, executive secretary, 616 Investment Building, Washington, D. C. A committee of the association is actively engaged in making a study of fertilizer analyses with the view of eliminating the unnecessary varieties.

National Fire Protection Association, Franklin H. Wentworth, secretary, 40 Central Street, Boston, Mass. In addition to individuals and State and municipal departments and bureaus, the membership of this organization consists of national institutes, societies, and associations interested in the protection of life and property against loss by fire. It is therefore largely an association of associations. Thirty-two technical committees have been organized to prepare standards and advisory pamphlets for the association. These committees are appointed by the president, vice president, and secretary, subject to the approval of the executive committee, and submit their reports to the association in annual meeting. Among the subjects upon which technical committees are now at

work are: Automatic sprinklers, blower systems, building construction, electric power houses, electric railway car houses and cars, farm fire protection, field practice, fire pumps, fire records, flammable liquids, garages, gases, hazardous chemicals and explosives, ordnance, manufacturing hazards, marine hazards, wharves, private fire supplies, protection of records, pyrotechnics, salvaging operations, signaling systems, storage of combustible fibers, and zoning. The standards of the association, some of which have been in existence about 30 years, are kept constantly under review, and are revised whenever changes are necessary. They are officially adopted by the National Board of Fire Underwriters and the organizations interested in fire protection or prevention. The association is represented on the joint fire-protection committee (with the American Water Works Association and the International Association of Fire Chiefs). It is sponsor or joint sponsor for six standardization projects or sectional committees functioning under the rules of procedure of the American Engineering Standards Committee, as follows: Safety code for building exits, regulations for electric wiring and apparatus in relation to fire hazard (National Electrical Code, edition of 1925), insulated wires and cables for other than telephone and telegraph use (with nine other associations), fire-fighting equipment in metal mines (with the American Mining Congress), standard threads for small hose couplings, safety codes for the prevention of dust explosions (with the United States Department of Agriculture). As a member of the fire protection group, it is joint sponsor for specifications for fire tests of materials of construction and specifications for rubber-lined fire hose. The association is represented on 13 additional sectional committees functioning under A. E. S. C. procedure.

National Founders Association, J. M. Taylor, secretary, 29 South LaSalle Street, Chicago, Ill. The membership of this association includes almost every variety of metal manufacture, such as sanitary ware, stoves, automobiles, builders' hardware, etc., each group of which is vitally interested in standardization, and has a trade association of its own through which standardization work is handled. Standardization, as such, is outside the scope of the activities of the association. However, it is joint sponsor, with the American Foundrymen's Association, for a safety code for the protection of industrial workers in foundries, formulated by a sectional committee under the rules of procedure of the American Engineering Standards Committee and is represented on two additional sectional committees under the auspices of the A. E. S. C.

National Hardware Association of the United States, George A. Fernley, acting secretary, 505 Arch Street, Philadelphia, Pa. This association, which is composed of wholesale distributers, has never

adopted any specifications. However, it has been active in the elimination of excess sizes and varieties of hardware under the auspices of the division of simplified practice, having cooperated in the initiation and formulation of simplified practice recommendations relating to builders' hardware; sheet steel; eaves troughs, conductor pipe, conductor elbows, and fittings; terneplate; loaded paper shot shells; and package sizes for insecticides and fungicides.

National Hardwood Lumber Association, Frank F. Fish, secretary, 2008 Straus Building, Chicago, Ill. For nearly 30 years the entire activities of the association have been devoted to the establishment and maintenance of uniform rules for the measurement and inspection of hardwood lumber. It has formulated, and keeps under constant review, the only rules in use for this purpose. On its inspection rules committee, appointed by the president, there are representatives of every known hardwood as well as of every producing center or large market. Objections raised to any proposed changes in the standards by groups of consumers are given full weight before they are put into effect. At the annual convention the committee submits proposed changes in the existing standards which become effective upon a favorable vote of two-thirds of the members present.

National Hay Association, The (Inc.), Fred K. Sale, secretary-treasurer, South Main Street, Winchester, Ind. The association has adopted grade rules for hay and straw which form the basis for the specifications for these commodities promulgated by the Federal Specifications Board. It has also adopted trade rules and inspection and weighing rules. When requested to do so it investigates the qualifications of inspectors and permits approved inspectors to make record of the association's approval on their official certificates of inspection.

National Lime Association, G. B. Arthur, secretary and general manager, 927 Fifteenth Street NW., Washington, D. C. Field research is an important activity of this association. It has promulgated specifications for lime plaster, lime stucco, lime mortar, and lime in concrete, as well as for lime in asphalt, concrete, and earth roads, and has cooperated with the American Society for Testing Materials in the preparation of specifications for quicklime and hydrated lime for various purposes. The association cooperated in the initiation of the work of the Building Code Committee of the Department of Commerce. It maintains a research associate at the National Bureau of Standards doing research work on the development of quick-setting lime plaster.

National Lumber Manufacturers Association, Wilson Compton, secretary-manager, Transportation Building, Washington, D. C. This organization comprises 13 regional associations of lumber manufacturers and timber owners. Standardization, one of its

important activities, is carried on by its manufacturers' standardization committee of one representative from each regional or subscribing association, which deals exclusively with softwood lumber. The association also has representation on the hardwood consulting committee, which is an independent committee made up of hardwood manufacturers, distributers, and consumers which reports direct to the Central Committee on Lumber Standards, made up of representatives of the entire lumber industry. The actions of the manufacturers' standardization committee are referred by its chairman to the Central Committee on Lumber Standards or to the consulting committee on lumber standards, which is also made up of representatives of the entire lumber industry, including representatives of lumber consumers, such as architects, contractors, engineers, purchasing officers, etc. At meetings of the manufacturers' standardization committee a regional association is entitled to only one vote, although more than one representative may be present. This committee is now preparing minor revisions and additions to the national standards for softwood lumber and assisting in securing their application in practice. The hardwood consulting committee, consisting of a fixed number of manufacturers, distributers, and consumers of hardwood lumber, is now formulating grading standards for hardwood lumber. The association cooperated in the initiation of the work of the building code committee of the Department of Commerce and the National Committee on Wood Utilization. It has taken a leading part in the organization and activities of the Central Committee on Lumber Standards and the consulting committee on lumber standards. It is officially represented on seven sectional committees functioning under A. E. S. C. procedure.

National Machine Tool Builders' Association, Ernest F. Du Brul, general manager, 630 Vine Street, Cincinnati, Ohio. Committees organized to prepare standards for the association are appointed by the president upon recommendation of the particular industrial group concerned. A proposed standardization project is undertaken only after a survey has been made of current practice to determine what is probably the most acceptable standard to be adopted, followed in some cases by research work to ascertain if current practice is the best possible practice. Committees are now at work on various types of machine tools and machine-tool elements, including T slots, now ready for issuance as a tentative standard. The association is joint sponsor for two sectional committees functioning under the rules of procedure of the American Engineering Standards Committee, as follows: Small tools and machine-tool elements (with the American Society of Mechanical Engineers), and safety code for machine tools (with the National Bureau of Casualty and Surety Underwriters).

The association is represented on four additional sectional committees functioning under A. E. S. C. procedure.

National Paper Box Manufacturers Association, Frank S. Records, executive secretary, 802 Liberty Trust Building, Philadelphia, Pa. This association has prepared and issued a dictionary of terminology for the set-up paper box industry covering several hundred trade terms, with their synonyms and accepted meanings relating to box construction, materials, machine processes, and measurements and types of boxes. It cooperated with the division of simplified practice in the establishment of standard minimum thicknesses of box board contained in simplified practice recommendation for this commodity.

National Paper Trade Association, William C. Ridgway, secretary, 41 Park Row, New York, N. Y. This association has cooperated with the National Association of Purchasing Agents and the division of simplified practice in developing standard sizes for catalogues and paper in sheets. Its recommended weights for writing paper have been adopted by the Writing Paper Manufacturers Association. It has adopted the standard sizes for tissue paper recommended by the division of simplified practice of the United States Department of Commerce.

National Paving Brick Manufacturers Association, Edward E. Duff, jr., secretary, Engineers Building, Cleveland, Ohio. The leading part in the movement which has resulted in the standardization of the sizes and varieties of paving brick has been taken by this association, which initiated the work by requesting the United States Department of Commerce through the division of simplified practice to call a conference of representatives of manufacturers, distributers, and users of paving brick for this purpose. It has acted as the authorized agent of the Department of Commerce in furnishing tabulations and analyses of shipments of vitrified paving brick, upon which have been based the successive steps in the process of eliminating excessive sizes and varieties. In four years the number of sizes and varieties has been reduced from 66 to 4.

National Petroleum Association, C. D. Chamberlin, advisory counsel, 1518 Guardian Building, Cleveland, Ohio, and F. B. Dow, general counsel, 930 Munsey Building, Washington, D. C. The association has organized a department of standards and tests which has been active in the preparation of specifications in cooperation with the American Society for Testing Materials, the Society of Automotive Engineers, and the Federal Specifications Board.

National Research Council, Vernon Kellogg, permanent secretary, 2101 B Street NW., Washington, D. C. The council, which was established in 1916 by the National Academy of Sciences, is a cooperative organization of the scientific men of America. Its essential

purpose is the promotion of research in the physical and biological sciences and the encouragement of the application and dissemination of scientific knowledge for the benefit of the Nation. It is composed of 11 major divisions, arranged in two groups. One group comprises 7 divisions of science and technology representing, respectively, physics, mathematics, and astronomy; engineering and industrial research; chemistry and chemical technology; geology and geography; the medical sciences; biology and agriculture; anthropology and psychology. The other group comprises 4 divisions of general relations, representing Federal relations, foreign relations, States relations, and educational relations. Each of these divisions comprises a larger or smaller series of committees, each with its special field or subject of attention. There are certain other committees, administrative and technical, which affiliate directly with the executive board of the council. Related to the executive board in a similar way is a research information service. In the division of chemistry and chemical technology the following organizations are officially represented: The American Chemical Society, American Electrochemical Society, American Institute of Chemical Engineers, and the American Ceramic Society. There are 9 committees and 14 subcommittees, the members of which are engaged in various kinds of work under this division. The committee on the substitution of sodium compounds for the conservation of potassium compounds is working with the committee on the revision of the United States Pharmacopœia and the committee on chemical methods of analsyis of the Association of Official Agricultural Chemists. The division acts as the American section of the International Union of Pure and Applied Chemistry. Cooperating with the division of engineering and industrial research are 12 organizations vitally interested in standardization which have appointed official representatives to serve on the division, as follows: The American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, American Society of Mechanical Engineers, American Institute of Electrical Engineers, American Society of Refrigerating Engineers, American Society for Testing Materials, American Society for Steel Treating, American Society of Heating and Ventilating Engineers, Illuminating Engineering Society, Western Society of Engineers, Society of Automotive Engineers, and the American Welding Society. This latter organization is now engaged in the work of formulating standard welded rail joints. The work of the division is carried on by 5 special committees and 10 subcommittees, composed of representatives of State and Federal departments and national organizations. In addition, the division has organized 6 advisory boards on research, each being sponsered by the national organizations most vitally interested in the subject, as follows: Civil engineering, mining and metallurgical

engineering, mechanical engineering, electrical engineering, testing materials, and welding. The following organizations are cooperating with the division in new investigations of pressure vessels: The American Society of Mechanical Engineers, American Welding Society, Association of Tank Manufacturers, American Petroleum Institute, American Society of Refrigerating Engineers, International Acetylene Association, and the National Electrical Manufacturers Association (apparatus division). The only work conducted at the present time by the council leading directly to standards is through the committee on the psychology of the highway of the division of anthropology and psychology, and its subcommittees on signs and signals and on tests for drivers. The functions of the subcommittees are to study the devising of highway signs and signals which will be in accordance with the correct principles of vision and mental reaction, and to study possible adaptation of systems of mental and physiological tests to the examination of drivers of automobiles, public and private. These subcommittees cooperate closely with the committee of the national conference on street and highway safety on the study of causes of accidents. The current activities of the subcommittee on signs and signals have consisted in a study of signal colors with special reference to the dominant wave lengths of the red and green standards in their relation to color-blind drivers. The subcommittee on tests for drivers has considered psychological methods to determine the competency of drivers. This subcommittee has cooperated with the committee on uniform laws of the traffic conference, and, in the matter of tests for drivers, with the officers of numerous taxicab companies. It has suggested improved parking signs which have been adopted in part by the Baltimore police department. Under the auspices of the International Research Council and the National Academy of Sciences, the National Research Council has prepared the International Critical Tables of Numerical Data, Physics, Chemistry, and Technology, being issued in five volumes, the first of which was published in 1926. The council maintains a research associate at the National Bureau of Standards doing research work on beta ray velocities. It is officially represented on the sectional committee on safety code for automobile brakes and brake testing functioning under the rules of procedure of the American Engineering Standards Committee.

National Retail Dry Goods Association, Lew Hahn, managing director, 225 West Thirty-fourth Street, New York, N. Y. This association has cooperated actively with other organizations in the standardization of bed blankets, radio apparatus, and the size of the United States flag. It has also engaged in the formulation of standards for accounting systems for retail stores, retail trade terminology, standards of practice for retail advertising, standards

of practice for operation of certain nonselling departments in retail stores, and retail store organization. The association at the present time is engaged in the formulation of standards for packing boxes and containers, and is also working on a standard form of invoice.

National Retail Hardware Association, H. P. Sheets, secretary, Meyer-Kiser Bank Building, Indianapolis, Ind. This association has cooperated with other organizations in eliminating excess varieties and sizes of hardware under the auspices of the division of simplified practice. It has been active in the initiation and formulation of simplified practice recommendations relating to builders hardware, loaded paper shot shells, and cut tacks and small cut nails.

National Safety Council, W. H. Cameron, managing director, 108 East Ohio Street, Chicago, Ill. In order to make most effective its accident-prevention work the council has organized a safe practice conference committee composed of 75 leading safety engineers in different parts of the country. To this committee are submitted the draft of each proposed safe practice pamphlet, formulated by a staff engineer and criticized by other leaders in the field covered by the pamphlet. The council has issued a total of 73 safe practice pamphlets, the last 6 in 1926, as follows: Pressure vessels, safety to the commercial driver, maintenance and repair men, handling of chlorine, safety committees, and foundries. During the year there was also issued the final report of the committee of the chemical and rubber sections of the council on "Health Hazards of Benzol." The council is sponsor or joint sponsor for 10 sectional committees functioning under the rules of procedure of the American Engineering Standard Committee, as follows: Safety code for construction work; identification of piping systems (with the American Society of Mechanical Engineers); safety code for floor and wall openings, railings, and toe boards; safety code for power presses and foot and hand presses; safety code for forging and hot metal stamping (with the American Drop Forging Institute); safety code for rubber machinery (with the International Association of Industrial Accident Boards and Commissions); colors for traffic signals (with the American Association of State Highway Officials and the National Bureau of Standards); codes on colors for gas-mask canisters; safety codes for textiles; safety code for paper and pulp mills; safety code for window washing. The American Society of Safety Engineers, which functions as a division of the National Safety Council, is sponsor or joint sponsor for three additional sectional committees, as follows: Safety code for ladders, safety code for walkway surfaces (with the American Institute of Architects), safety code for compressed-air machinery (with the American Society of Mechanical Engineers). The National Safety Council is officially represented on 35 additional sectional committees functioning under A. E. S. C. procedure.

National Sand and Gravel Association, V. P. Ahearn, executive secretary, Suite 434 Munsey Building, Washington, D. C.; Stanton Walker, director, engineering and research division. The standardization work of this organization is conducted through committees appointed by the president with the advice and consent of the executive committee. The functions of these committees are to prepare specifications in the form of recommendations to be submitted to the association at annual conventions. In 1926 the association published a special bulletin on the Importance of Uniform Aggregates in Control of Concrete Mixtures, and the committee on washed gravel ballast, in cooperation with the American Railway Engineering Association, prepared a specification for washed gravel ballast, which was adopted by the association. Committees on standard depreciation scale and specifications for standardized sizes of sand and gravel have prepared recommendations to be submitted to the association at its annual convention in 1927.

National Slag Association, H. J. Love, secretary, 933 Leader-News Building, Cleveland, Ohio. Although this association has not formulated any standards or specifications, its engineering and problems committee is actively engaged in the work of gathering and analyzing the results of current tests made of construction materials. This committee is composed of members, most of whom in turn are on one or more standing committees of the American Concrete Institute, the American Society for Testing Materials, and other technical societies. The association is cooperating not only with technical societies but also with Government bureaus, universities, colleges, State departments, firms, and individuals who possess laboratories in which construction materials are tested. It maintains a research associate at the National Bureau of Standards, conducting investigations on the durability of slag as a mineral aggregate.

National Slate Association, W. S. Hays, secretary, Drexel Building, Philadelphia, Pa. Standardization committees of the association are appointed annually at the slate industry conference to establish standard methods of producing and utilizing slate. Both producers and consumers are represented on the committees, and special efforts are made to ascertain the attitude of unorganized groups toward any proposed standard. The association has issued recommended specifications for slate roofs, floors, walks, and blackboards; and slate for electrical, plumbing, and sanitary purposes. It has cooperated with the division of simplified practice in the simplified practice recommendations relating to structural slate, roofing slate, and blackboard slate. In 1925 it published its standard specifications for slate for floors, terraces, and walks in a folder entitled "The Charm of Slate Floors and Walks." In 1926 it published its

standard specifications for slate for flat and sloping roofs in a book entitled "Slate Roofs." There is under preparation standard specifications for structural uses and other possibilities in the use of slate.

National Terra Cotta Society, F. S. Laurence, executive secretary, 19 West Forty-fourth Street, New York, N. Y. This association has formulated standard specifications for the manufacture, furnishing, and setting of terra cotta. It has also prepared a short-form specification for incorporation in the architect's specifications to be used in connection with standard specifications and the standard general conditions of the American Institute of Architects. The association is officially represented on sectional committees on specifications for fire tests of materials of construction, and architectural terra cotta and methods of setting, functioning under the rules of procedure of the A. E. S. C. It maintains three research associates at the National Bureau of Standards doing research work on the investigation of architectural terra cotta.

National Wholesale Grocers' Association of the United States, M. L. Toulme, secretary, 6 Harrison Street, New York, N. Y. Although not making standardization a major activity, the association cooperates in making effective many of the standards adopted by organizations interested in the several kinds of food products. In cooperation with the Rice Millers' Association it has adopted a standard form of contract for the sale of rice based on the grades and specifications of the United States Department of Agriculture. It has approved the standard form of contract for canned goods adopted in cooperation with the Canners League of California, Western Canners' Association, and many other organizations representing producers of food products.

Natural Gas Association of America, The, Guy F. Batchelor, general secretary, Oliver Building, Pittsburgh, Pa. This association has established a code in which are included the standards of procedure formulated by the association through the recommendations of its several committees. The association, through its several committees, secures the cooperation of the various interested organizations and governmental departments before the adoption of each standard. The code is kept under constant review by committees organized to recommend changes and additions. The following subcommittees, the names of which indicate the scope of their activities, are functioning for this purpose: Gas utilization, gas measurements, gas transportation, and gas distribution. The association has adopted tentative standards for three methods of testing natural gas to determine gasoline content, namely, compression and cooling, oil absorption, and charcoal absorption. It has also adopted a tentative standard for meter connections.

New England Water Works Association, F. J. Gifford, secretary, 715 Tremont Temple, Boston, Mass. This association is cooperating with the American Gas Association, American Society for Testing Materials, and the American Water Works Association in serving as joint sponsors for the sectional committee on specifications for cast-iron pipe and special castings, and is officially represented on the sectional committee on pipe flanges and fittings functioning under A. E. S. C. procedure.

Optical Society of America, C. C. Bidwell, secretary, Cornell University, Ithaca, N. Y. This society's committee on color terminology has conducted an active campaign to enlist the cooperation of all interested organizations and professions in its effort to standardize the words used to describe the different characteristics of color.

Paperboard Industries Association, G. R. Browder, general manager, 608 South Dearborn Street, Chicago, Ill. This association, which has taken over the activities of the following heretofore existing associations, namely, the Box Board Association, the National Container Association, and the Folding Box Manufacturers Association, is composed of manufacturers of paper board, corrugated and solid fiber containers, and folding boxes. It is working along standardization lines through a standardization committee, the functions of which are to study and recommend changes in or additions to the existing standards for paper board, containers, and folding boxes, and specifications for such material as tape, adhesives, etc. Subjects for consideration are referred by members to the association, which places them before the standardization committee, and recommendations of this committee are in turn submitted to the membership of the association for ratification before being made effective. The committee is now preparing a book of standards, which will contain standard gauge lists effective in the paper board, container, and folding box industries; standard mill specifications covering the purchase of board to be used in shipping containers and folding boxes, as well as standard trade customs. It is also working on proposed changes in specifications for shipping containers as prescribed by carriers. Members of the association are privileged to use its insignia in connection with the certificates used by manufacturers showing that boxes bearing these certificates conform to all construction requirements of the Consolidated Freight Classification or the Official Express Classification.

Plate Glass Manufacturers of America, P. A. Hughes, secretary, First National Bank Building, Pittsburgh, Pa. This association has cooperated in the preparation of specifications for plate glass for glazing purposes, which are included in the United States Government master specifications for flat glass for glazing purposes.

Plumbago Crucible Association, C. H. Rohrback, secretary, 90 West Street, New York, N. Y. As the result of investigation extending over several years, the association inaugurated the standardization of crucible sizes on a scientific basis. It served as joint sponsor with the American Foundrymen's Association for a sectional committee which formulated size numbers and outside dimensions of plumbago crucibles for nontilting furnaces in nonferrous foundry practice, approved as tentative American standard under A. E. S. C. procedure.

Portland Cement Association, W. M. Kinney, general manager, 33 West Grand Avenue, Chicago, Ill. Organized to improve and extend the use of concrete, this association has cooperated with the A. S. T. M. in formulating specifications and tests for Portland cement recognized as the American standard, and all of its members manufacture in accordance with these specifications. It is represented, with four other organizations, on the joint committee on standard specifications for concrete and reinforced concrete. It cooperated in the initiation of the work on the building code committee of the Department of Commerce. It is officially represented on six sectional committees functioning under A. E. S. C. procedure. The association maintains seven research associates at the National Bureau of Standards doing research work on phase equilibria, synthetic cements, pure cement compounds, influence of minor constituents, catalytic effects, hydrolysis, hydration, disintegration, thermal effects in the setting process, consistency, solution equilibria, petographic mineral analysis, optical constants of constituents, and the X-ray examination of clinkers.

Refrigerating Machinery Association, The, Fred Nolde, secretary-treasurer, 23 South Fifty-second Street, Philadelphia, Pa. Through its standardization committee, the association is officially represented on the sectional committee functioning under the rules of procedure of the A. E. S. C. under joint sponsorship of the American Society of Mechanical Engineers, the Heating and Piping Contractors National Association, and the Manufacturers Standardization Society of the Valve and Fittings Industry in the preparation of national standards for flanges, fittings, and valves. It is cooperating with the structural service committee of the American Institute of Architects on the preparation of standardized specifications for refrigerating equipment. It is officially represented on a joint committee in the preparation of a national code of pressure piping. It is also represented on a joint committee with the Electric Power Club and the Compressed Air Society for considering standardized specifications for synchronous motors for use in connection with air compressors and refrigerating machines.

Rice Millers' Association, F. B. Wise, secretary, P. O. Box 1289, New Orleans, La. In addition to establishing standard contract

forms and rules for sale which are adhered to by practically all rice shippers, the association issues inspection certificates based on the grades and specifications for milled rice recommended by the United States Department of Agriculture. It maintains a corps of samplers in the field and a laboratory equipped to test rice for quality, grade, and condition.

Rubber Heel Club of America, The, George A. Stetson, secretary, 370 Atlantic Avenue, Boston (9), Mass. As a result of the work of a joint committee composed of rubber-heel manufacturers of this organization and members of the National Boot and Shoe Manufacturers Association to consider recommendations for the elimination of various sizes and the adoption of standard sizes, 24 different sizes of rubber heels for ladies and juniors were adopted. This represents a reduction of 18 sizes from the current 42 sizes. The number of sizes of men's whole heels and half heels were also reduced from 12 to 8 sizes and 19 to 15 sizes, respectively. The work thus inaugurated is now being carried on by the rubber heel and sole department of the Rubber Association of America.

Sand-Lime Brick Association, G. W. Phelps, secretary, Flint, Mich. This association has not formulated any standards or specifications for sand-lime brick. However, it cooperated actively in the compilation of data used as a basis for a recommended standard size of and quality specification for sand-lime brick which is contained in the division of simplified practice recommendation for this commodity.

Sheet Steel Trade Extension Committee, C. L. Patterson, secretary, Oliver Building, Pittsburgh, Pa. This committee is made up of representatives of manufacturers of sheet steel. It has established quality standards for steel sheets and issues licenses to mills to apply its "master brand" to sheet steel complying therewith as to quality and gauge of steel and weight and quality of coatings if galvanized. The product of these mills is subject to regular inspection by the committee.

Silk Association of America, The (Inc.), Ramsay Peugnet, secretary, 468 Fourth Avenue, New York, N. Y. The standardization and simplification activities of this association are conducted through several committees appointed by the board of managers or the president and through special departments or bureaus within the association's paid organization. The reports of these committees are submitted to the board which acts officially for the organization. The raw silk classification committee, with the aid of seven laboratory experts, is actively engaged in the preparation of a classification for the grading of raw silk and in the adoption of standard methods of testing. This committee has also simplified trade terms used for different kinds and grades of silk. Another committee has been

organized to cooperate with the Government in preparing specifications for silk articles sufficiently simple to meet the requirements of the Government and yet be practical for the manufacturer. The association is cooperating with the Laundryowners' National Association, textile chemists and soap manufacturers in the development of formulas for washing silk fabrics, taking into account the necessity of thoroughly cleansing the fabric without removing the color. Four special committees have developed further the association's rules and regulations governing transactions in raw silk, thrown silk, spun silk, and commission throwing. These rules and regulations aim to standardize trade practices and sales contracts. Another committee is developing specifications for domestic raw silk waste. All of these committees are selected in such a way as to make them representatives of all of the different interests within the association. The association is officially represented on the sectional committee on rating of electrical machinery functioning under the rules of procedure of the American Engineering Standards Committee.

Society of American Foresters, J. H. Fahrenbach, secretary, 314 Takoma Avenue, Takoma Park, Md. Although the society has never formulated or adopted any specifications for materials, it has taken an active interest in the work going forward under the auspices of the American Engineering Standards Committee, and is officially represented on the sectional committees on safety code for logging and sawmill machinery; methods of testing wood; and specifications for railroad ties, wood and steel poles.

Society of Automotive Engineers (Inc.), C. F. Clarkson, secretary and general manager, 29 West Thirty-ninth Street, New York, N. Y. For the formulation of engineering standards and recommended practices for the automotive and related industries, the council of the society annually appoints a standards committee, the chairman and vice chairmen of which are designated by the president. At present the standards committee comprises 25 divisions, the chairman and vice chairman of each being designated by the president. Nine of the divisions represent distinctive groups of automotive vehicles and unit plants, 12 various classifications of parts or subunits, 3 materials, and 1 manufacturing operations. Preliminary reports relating to any proposed standard are published in the society's journal for criticism. When approved by the division to which the subject has been assigned and by the council and acted upon favorably at a general business meeting of the society, the proposed standard is submitted to letter ballot of the society membership, and upon approval is published in the handbook as a society specification. In the present edition of the handbook, which is revised and published twice a year, are more than 600 specifications. In 1926, 64 standardization projects were passed upon by the

society's standards committee and approved by the society for adoption. Among these were specifications for upholstery leather; automobile lighting-ciruit fittings; storage batteries; electric wire and cable; engine parts and accessories and their mountings; roller bearings; crank-case lubricating-oil specifications; bolts, nuts, and wrench openings; screw-thread fits and tolerances; low-pressure tire sizes and mechanical parts, such as brake lining and flexible disks for couplings. Advertising in the handbook is limited to automobile parts made in accordance with the society's specifications, certificates being signed by proper officials of the manufacturing firms to the effect that the products advertised comply with the designated specifications. Of the 116 current standardization subjects, many include various parts and materials for airplanes; thrust ball bearings; automotive power plants and mountings; material specifications and tests; automobile headlighting specifications; tires and wheel equipment; screws, drills, and taps; and a variety of mechanical parts and fittings; paints, varnishes, and enamels; and materials such as substitutes for upholstery leather. The society is joint sponsor for nine sectional committees functioning under the rules of procedure of the American Engineering Standards Committee, as follows: Standardization and unification of screw threads (with the American Society of Mechanical Engineers); ball bearings (with the American Society of Mechanical Engineers); bolt, nut, and rivet proportions (with the American Society of Mechanical Engineers); pins and washers, and machine-tool elements (with the American Society of Mechanical Engineers); transmission chains and sprockets (with the American Society of Mechanical Engineers and the American Gear Manufacturers Association); safety code for aeronautics (with the National Bureau of Standards); automobile headlighting specifications—laboratory tests for approval of electric headlighting devices for motor vehicles (with the Illuminating Engineering Society); numbering of steels (with the American Society for Testing Materials); wire and sheet-metal gauges (with the American Society of Mechanical Engineers). The society is officially represented on 13 additional sectional committees functioning under A. E. S. C. procedure. During 1926 the society was also represented on about 30 other committees or boards of other national organizations or governmental bureaus and departments, among which are the American Automobile Association; the American Bureau of Welding; American Society for Steel Treating; various committees of the American Society for Testing Materials, and committees of the National Bureau of Standards; Army and Navy aeronautic conferences; consulting committees of the Central Committee on Lumber Standards; National Advisory Committee for Aeronautics; National Research Council, advisory board of the Governmental Technical Committee on Lubricants

and Liquid Fuels; National Screw Thread Commission, and the National Automobile Chamber of Commerce. The society maintains two research associates at the National Bureau of Standards doing research on fuels.

Society of Industrial Engineers, The, George C. Dent, executive secretary, 608 South Dearborn Street, Chicago, Ill. The society has organized a committee on standard management terminology for the purpose of studying laws and principles of the science of management. It has also appointed a committee to study practical methods for the elimination of waste in manufacturing, including standardization and simplification. The society is officially represented on three sectional committees functioning under A. E. S. C. procedure.

Society of Naval Architects and Marine Engineers, Daniel H. Cox, secretary, 29 West Thirty-ninth Street, New York, N. Y. This society has taken part in the standardization movement in cooperation with other interested organizations. It is a member of the American Marine Standards Committee and is serving as joint sponsor, with the American Society of Civil Engineers and the Association of American Steel Manufacturers, for the sectional committee on structural steel shapes functioning under the rules of procedure of the American Engineering Standards Committee. It is represented on 14 additional sectional committees functioning under A. E. S. C. procedure.

Society for the Promotion of Engineering Education, F. L. Bishop, secretary, University of Pittsburgh, Pittsburgh, Pa. The standardization activities of this society are limited to work having a direct bearing upon the teaching of engineering subjects. It is serving as joint sponsor for two sectional committees functioning under the rules of procedure of the American Engineering Standards Committee, as follows: Scientific and engineering symbols and abbreviations (with four other organizations), and standards for drawings and drafting room practice (with the American Society of Mechanical Engineers).

Southern Pine Association, H. C. Berckes, secretary, New Orleans, La. One of the functions of the association is the maintenance of standard grades for southern pine lumber and the supervision of the mills to assure uniformity in their manufactured products. Through the Central Committee on Lumber Standards and the National Committee on Wood Utilization it has cooperated with the Department of Commerce in the national wood standardization program. Its standardization activities are conducted under the supervision of its grading committee, appointed annually, which has charge of the association's inspection department. Its staff of inspectors visit the plants of the member firms monthly to check up the work of the mill

graders. Firms receiving this service place the mark of the expert grader on all of the lumber they make.

Southern Sash, Door, and Millwork Manufacturers' Association, C. B. Harman, secretary, 1621 Candler Building, Atlanta, Ga. The standardization activities of this association are conducted through standardization committees appointed by the president. These committees investigate, consider, formulate, and make reports of their findings and recommendations for final consideration and adoption to the members of the association in convention. Recommendations adopted are sent by mail to each member of the association, and, where necessary, are put into printed form for general circulation and use. The association has set up standards for sizes, grades, and designs for sashes, doors, and millwork. It has established standard methods for millwork cost accounting. During 1926 the uniform millwork contract committee prepared a uniform millwork contract and definition of millwork, including standard specifications of manufacture, which has been adopted by the association.

Steel Barrel Manufacturers Institute, D. S. Hunter, secretary, 428 Bulkley Building, Cleveland, Ohio. Standardization activities of this organization are conducted by its committee on specifications and standards. Through this committee, it has adopted minimum weights for barrels of various types and sizes, and standard threads for bung openings and standard distances between rolling hoops. It initiated the movement which resulted in the simplified practice recommendation relating to the sizes of steel barrels and drums. All members of the institute have pledged themselves to adhere to the standards developed by the institute or established by the Interstate Commerce Commission.

Steel Founders' Society of America, William J. Corbett, secretary-manager, 511 Magee Building, Pittsburgh, Pa. In addition to its standardization activities which have resulted in promoting the use of uniform cost-accounting methods throughout the industry, the society cooperates with a number of organizations in establishing standards. It cooperates with the American Society for Testing Materials in formulating specifications for steel castings, and is represented on the joint committees on pattern equipment standardization; on foundry refractories; and on the investigation of the effect of sulphur and phosphorus in steel. As a result of its request the National Committee on Metals Utilization has organized a committee on foundry practice to consider as its first problem the subject of having the weights of castings shown on blue prints sent to foundries.

Structural Service Bureau, A. Lynwood Ferguson, secretary, 112 South Sixteenth Street, Philadelphia, Pa. Although this bureau has not formulated any specifications, it has actively cooperated in the

preparation of standards, building codes, and specifications which have been promulgated by the National, State, and municipal authorities, and in the compilation and issuance of specifications which have been adopted by the following organizations: The Associated Tile Manufacturers, Common Brick Manufacturers Association, National Slate Association, National Lime Association, Eastern Clay Products Association, and a number of individual firms.

Tap and Die Institute, Herbert S. Blake, secretary, 120 Broadway, New York, N. Y. The standing committee on simplification and standardization is actively engaged in the task of eliminating from catalogue lists, sizes and styles of taps and dies which the trade no longer demands, and is establishing proper standard basic mechanical sizes of these tools to be listed in revised catalogues. The membership acts upon the recommendations of the committee submitted at general meetings of the institute.

Telephone Group. In connection with the standardization activities conducted under the auspices and procedure of the A. E. S. C. the telephone industry operates as a group. The telephone group is sponsor or joint sponsor for two sectional committees functioning under the rules of procedure of the A. E. S. C., as follows: Manhole frames and covers (with the American Society of Civil Engineers) and specifications for wood poles. It is officially represented on two additional committees functioning under A. E. S. C. procedure. This group consists of the Bell Telephone System and the United States Independent Telephone Association. The A. E. S. C. executive committee representative of the group is F. L. Rhodes, of the Bell Telephone System, 195 Broadway, New York, N. Y. C. C. Deering, 19 South La Salle Street, Chicago, Ill., is secretary of the United States Independent Telephone Association. Within the Bell Telephone System the work of standardization of materials and methods is not performed by committees, but by groups of experts of the joint staff flexibly organized. The staff has formulated a sufficiently wide range of standards to meet ordinary needs. From these standards the operating units of the system make their own choice of what will best meet their conditions. The standards are kept continually under review, and revisions are made as frequently as desirable to meet changed economic conditions and considerations of service. The United States Independent Telephone Association has organized a plant division chiefly for the purpose of acting as a clearing house to gather and promulgate facts of value to the member companies, and to represent the association in its cooperative work with outside interests, such as the American Engineering Standards Committee, the National Electric Light Association, and the National Bureau of Standards. It has been active in the organization and work of the American Committee on Inductive

Coordination, which includes representatives of not only the telephone and electric-light groups, but also the electric-railway group and the steam and the electrified railroad group.

Textile Color Card Association of the United States (Inc.), Margaret Hayden Rorke, managing director, 50 East Forty-second Street, New York, N. Y. This association has developed a standard color card based upon a plan, in accordance with which each color is given a number consisting of four figures which express as nearly as can be done the character of the color. The card is used in the textile and allied industries to identify the colors by the number assigned to them.

Tire and Rim Association of America, The (Inc.), C. E. Bonnett, general manager, 1401 Guarantee Title Building, Cleveland, Ohio. This association, composed of manufacturers of vehicle tires, rims, wheels, bases, or their related parts, was organized for the purpose of conducting standardization and inspection work. The association has formulated and adopted standards for rims, and carries on the work of inspection to see that rims conform to the standards set by it.

Tissue Paper Manufacturers Association, E. H. Naylor, secretary, 44 Vernon Street, Springfield, Mass. The association, in cooperation with the National Paper Trade Association, has adopted and promulgated standard sizes for tissue paper in accordance with simplified practice recommendations of the United States Department of Commerce. Members of the association are authorized to use the official label and the seal of the association in guaranteeing the packages to be in accordance with simplified practice recommendation as to size and count.

Underwriters' Laboratories, Dana Pierce, president, 207 East Ohio Street, Chicago, Ill. For about 25 years the laboratories have been maintained by the National Board of Fire Underwriters for examining and testing appliances and devices on contracts entered into with the owners and manufacturers of such appliances and devices, respecting the recommendation thereof to insurance companies. The technical work of the laboratories is conducted under the supervision of five councils—the fire council, the electrical council, the casualty council, the automotive council, and the burglary protection council. Standards are adopted by vote of a council on recommendations made by the staff of the laboratories generally after consultation and collaboration with an appropriate industry conference. Definite specifications relating to design details and performance characteristics have been formulated by the laboratories, with special reference to life and fire hazards and accident and theft prevention. Arrangements are made with manufacturers for the inspection of devices and materials at the factories by laboratories inspectors, and standard goods are identified by stamps, transfers,

labels, or other markings whereby they may be recognized wherever found. As a member of the fire-protection group of the American Engineering Standards Committee, the laboratories is joint sponsor for specifications for rubber-lined fire hose (with the American Society for Testing Materials) and specifications for the fire tests of materials and construction (with the American Society for Testing Materials and the National Bureau of Standards). It is officially represented on 16 additional sectional committees functioning under A. E. S. C. procedure. In cooperation with the National Board of Fire Underwriters, the National Fire Protection Association, and many other insurance, technical, and engineering societies, it assists, through its staff, in the formulating of standards and regulations covering fire-loss prevention, accident, and theft.

United States Pharmacopœial Convention, Lyman F. Kebler, M. D., secretary, 1322 Park Road NW., Washington, D. C. One of the prime objects of this body is to establish uniform standards for the use of those engaged in the practice of medicine and pharmacy in the United States whereby the identity, strength, quality, and purity of certain recognized medicines and drugs may be accurately determined. The delegates of this organization represent various branches of the United States Government; the incorporated State, medical, and pharmaceutical associations; all incorporated and eligible medical colleges and schools of pharmacy; and the following national associations: The American Medical Association; American Pharmaceutical Association; American Chemical Society; Association of American Dairy, Food, and Drug Officials; Association of Official Agricultural Chemists; National Wholesale Druggists' Association; National Association of Boards of Pharmacy; National Association of Retail Druggists; American Drug Manufacturers' Association; and the National Dental Association. For over 100 years the members of this association have been engaged in the work of determining and fixing standards for certain drugs, simple and compound, possessing definite therapeutic merit. Through its committee on revision the convention revises the United States Pharmacopœia at intervals of 10 years. The Pharmacopœia describes and give standards for such drugs as are recognized therein. It is published by the board of trustees of the convention. The tenth decennial revision became effective January 1, 1926. Much of the work on revision is conducted by means of correspondence. Conferences are also held by the members of the committee on revision and subcommittees, meeting in different parts of the United States. Hearings are granted to groups of manufacturers, chemists, and others interested having special information concerning the manufacture, quality, purity, test, and standardization of the various official products. These conferences are of great value in finally

fixing the standards. The companion book, the National Formulary, the fifth edition of which became official July 1, 1926, is revised by a special committee, appointed by the council of the American Pharmaceutical Association and published and controlled by this association. Its chief purpose is to supply definite formulas for preparations that are sufficiently used in medical practice, and to provide standards and tests for the identity, quality, and purity of the essential ingredients used in compounding same not otherwise provided for by a recognized authority. The United States Pharmacopœia and National Formulary, official at the time of investigation, are recognized as authorities by the national food and drugs act of June 30, 1906, and similar laws of many States in the Union. The term "drug" under the national law includes all medicines and preparations recognized by these two standards "for internal and external use, and any substance or mixture of substances intended to be used for the cure, mitigation, or prevention of disease of either man or other animals." In former revisions the committees were very greatly handicapped in procuring important information to provide standards. Manufacturers were particularly jealous of their secrets, but since the passage of the national food and drugs act information has been freely tendered.

United Typothetæ of America, Edward T. Miller, secretary, 600 West Jackson Boulevard, Chicago, Ill. This organization has undertaken the preparation of a dictionary of printing terms to include standard definitions of the various operations in printing and binding. It publishes a standard form of proposal for printing in which are incorporated the standard printing trade customs. Its research department has made a special study of printing processes and methods. The organization has taken an active part in promoting the standardization of paper sizes, in cooperation with the National Association of Purchasing Agents and the division of simplified practice.

Wholesale Sash and Door Association, N. L. Godfrey, secretary, 1210 Steger Building, Chicago, Ill. This association has not formulated any specifications. However, it has prepared and issued booklets containing standard lists of designs, sizes, and layouts for open sash, glazed sash, panel door, outside blinds, and wood moldings.

Writing Paper Manufacturers Association, E. H. Naylor, secretary, 44 Vernon Street, Springfield, Mass. The association has adopted and promulgated certain trade customs relating to writing paper, including standard sizes and weights. The weights listed are those recommended by the National Paper Trade Association. It has approved a classification of cotton rags promulgated by the National Association of Waste Material Dealers.

X. TESTING AND CERTIFICATION FOR THE CONSUMER

CERTIFICATION PLAN

Notwithstanding the immense amount of time and labor represented in the formulation of specifications, the fact remains that many excellent specifications, well recognized throughout industry, are not being widely used at the present time because of the inability on the part of most purchasers to determine whether or not commodities delivered correspond to the specification requirements. A great impetus to the popularizing of the use of specifications could be given by eliminating this disadvantage to the small-quantity purchaser.

The so-called "certification plan" has been inaugurated as a solution to the problem of eliminating the above-mentioned disadvantage and thereby promoting the use of specifications. In carrying out this plan there are compiled lists of manufacturers who have expressed their desire to supply material in accordance with certain selected nationally recognized specifications and are willing to certify to the purchaser, upon request, that the material thus supplied is guaranteed to comply with the requirements and tests of the specifications.

From time to time the State purchasing agents have sought the assistance of the Department of Commerce in the formulation of standards, specifications, and methods of tests for their purchases. With the approval of the State governors, Secretary Hoover called a conference of the purchasing agents of the States on May 25, 1923, to ascertain in what way the department could best be of service to the public purchasers in connection with the formulation, selection, or unification of specifications and in the development of methods of testing. This conference expressed its approval of the proposal of the department to review the entire field of standards, specifications, simplifications, and tests to determine those best adapted for public purchasers.

Every effort is being exerted to make the certification plan as effective as possible for "public purchasers"; that is, purchasers for the Federal, State, and municipal governments who are spending the money collected from the public in the form of taxes.

Among the duties assigned to the Federal Specifications Board are not only the compilation and adoption of standard specifications for materials and services but also the bringing of the Government specifications into harmony with the best commercial practice whenever conditions permit, bearing in mind the broadening of the field of supply.

Encouraging the maximum possible number of purchasing agents to make use of the specifications of the Federal Specifications Board

would broaden the field of supply by inducing the maximum possible number of producers to manufacture commodities meeting the requirements of the Federal Government. Moreover, the widespread use of specifications of the Federal Specifications Board would serve to draw attention to such modifications as might well be made therein in order to render them satisfactory to the buying public and to bring them into harmony with the best commercial practice.

There have already been compiled by the National Bureau of Standards 48 lists of such firms as have expressed to the bureau (up to January 1, 1927) their desire to have their names placed on the lists of manufacturers willing, when requested to do so, to certify to purchasers that material supplied in accordance with the designated 48 United States Government master specifications complies with the requirements and tests of these specifications and is so guaranteed by them. The specifications referred to are as follows:

Specification No.	Commodities covered
23.	Large tungsten filament incandescent electric lamps.
36a.	Fire-extinguishing liquid (carbon tetrachloride base).
52.	Wood screws.
55.	Cutout bases.
57.	Flexible nonmetallic tubing.
58.	Dry cells.
62.	Snap switches.
65.	Rubber covered wires and cables for ordinary purposes.
123.	Flat glass for glazing purposes.
124.	Hand chemical fire extinguishers (1 quart carbon tetrachloride type).
175.	Knife switches.
191.	Brush, blacking and dauber.
192.	Brush, casting.
193.	Brush, clothes scrubbing.
194.	Brush, cuspidor.
195.	Brush, dauber, long paddle.
196.	Brush, deck scrubbing.
197.	Brush, hand floor scrubbing.
198.	Brush, hair, military.
199.	Brush, radiator dusting.
200.	Brush, shaving.
201.	Brush, sidewalk.
202.	Brush, tooth.
203.	Brush, window.
204.	Broom, rattan push.
205.	Broom, rattan (upright).
206.	Broom, scrubbing.
207.	Broom, wire push.

Specification No.	Commodities covered
208a.	Duster, counter.
213.	Hand chemical fire extinguisher (soda and acid type).
242.	Wrought iron pipe (welded) (black and galvanized).
287.	Tubing, copper, seamless, and pipe, copper, seamless, standard iron pipe size.
291.	Friction tape.
292.	Rubber insulating tape.
297.	Wire rope.
311.	Rigid conduit, enameled.
312.	Rubber gloves for electrical workers (for use in connection with apparatus or circuits not exceeding 3,000 volts to ground).
314.	Railroad track scales.
332.	Broom, whisk.
333.	Broom, corn.
336.	Builders' hardware.
342.	Pipe, brass, seamless, iron pipe size, standard and extra strong.
343.	Cast-iron soil pipe and fittings, coated and uncoated.
347.	Lap-welded and seamless steel boiler tubes.
349.	Lap-welded charcoal iron boiler tubes.
362.	Liquid measuring devices, retail type.
363.	Burglar resisting safes.
411.	Tableware, silver plated.

Reference is made herein specifically to Federal Government master specifications as the lists referred to are those of manufacturers willing to certify to compliance with these specifications. However, the plan outlined could readily be, and is being, applied to other groups of nationally recognized specifications. It is to be expected that the application of the plan will be of benefit, not only in the general promotion of the use of specifications by both the small and the large consumers, but also in the unification of specifications having national recognition.

Beginning with March, 1926, the Handbook of the Society of Automotive Engineers has been carrying advertisements restricted to the products of firms that have certified to the S. A. E. that the parts and materials advertised have been manufactured in accordance with S. A. E. specifications. Doubtless the plan will result in furthering the adoption of the standards of the S. A. E. with much benefit to the automotive industry. It will be beneficial in promoting the use of specifications throughout industry in general.

In view of the fact that the specifications of the Federal Specifications Board and those of the Society of Automotive Engineers are being used rather considerably at the present time, it is believed that no confusion will be created by having the firms certify that the commodities manufactured and delivered on orders based on these specifications do actually comply therewith. In fact, the application of the certification plan to several groups of nationally recognized specifications will serve to draw attention to the present confusion and arouse interest in a greater uniformity of standards.

The executive committee of the American Society for Testing Materials has formally expressed the opinion that the certification plan should be applied to the specifications approved by the American Engineering Standards Committee. This proposal is now being given consideration by a special committee of the A. E. S. C.

That there is nothing revolutionary in the certification plan can be shown by calling attention to a number of somewhat similar plans already in successful use.

Among the agencies that are now engaged in, or have definitely planned for, activities tending to bring about a change from the prevalent hit-or-miss method of specifying, hit-or-miss method of manufacturing, and hit-or-miss method of testing, to a logical method of formulating specifications, manufacturing in conformity therewith, and testing to insure or guarantee compliance, are the following:

1. American Chemical Society.
2. American Corn Millers Federation.
3. American Gas Association.
4. American Institute of Baking.
5. American Malleable Castings Association.

6. American Medical Association.
7. American Petroleum Institute.
8. American Railway Association, Freight Container Bureau.
9. American Society of Agricultural Engineers.
10. American Society of Mechanical Engineers.
11. American Society for Testing Materials.
12. Asphalt Shingle and Roofing Association.
13. Associated Cooperage Industries of America.
14. Associated Factory Mutual Fire Insurance Companies.
15. Associated General Contractors of America.
16. Associated Knit Underwear Manufacturers.
17. Associated Tile Manufacturers.
18. Associates for Government Service.
19. Association of Official Agricultural Chemists (enforced by the Agricultural Department).
20. Canners' League of California.
21. Concrete Products Association.
22. Eastern Clay Products Association.
23. General Supply Committee, Treasury Department (list of successful bidders).
24. Grain Dealers National Association (polices its members under United States standard grain grading).
25. Heating and Piping Contractors National Association.
26. Hollow Building Tile Association.
27. Interstate Cotton Seed Crushers Association.
28. Maple Flooring Manufacturers Association.
29. National Board of Fire Underwriters.
30. National Canners Association.
31. National Hay Association.
32. Paperboard Industries Association.
33. Periodicals (such as Good Housekeeping, Modern Priscilla, and Popular Science Monthly) issue certificates of approval for trade-brand articles.
34. Portland Cement Association.
35. Rice Millers' Association.
36. Sheet Steel Trade Extension Committee.
37. Society of Automotive Engineers.
38. Southern Pine Association (grading under American standards).
39. Steamboat Inspection Service.
40. Steel Barrel Manufacturers Institute (I. C. C. specifications).
41. Tire and Rim Association of America.
42. Vitreous China Plumbing Fixture Manufacturers.

The standardization activities of the technical societies, trade associations, and similar agencies listed above are outlined in Chapters VIII and IX.

COMMERCIAL TESTING LABORATORIES

In recognition of the desirability under present conditions of independent commercial testing service and in anticipation of a marked increase in the demand for such service in both domestic and export trade, there has been compiled by the National Bureau of Standards a list of laboratories throughout the country that are prepared to test various kinds of commodities to determine whether or not they

comply with purchase specifications. This list is printed as Bureau of Standards Miscellaneous Publication No. 90, and it can be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C.

The existence of a thoroughly classified list of commercial testing laboratories, together with a list of other reliable "checking agencies," will have a number of beneficial effects in promoting the use of specifications not the least important of which will be the inducement offered to the large number of purchasers who have hitherto hesitated to buy on specifications.

Heretofore purchasers not individually equipped to make their own acceptance tests have been reluctant to adopt the specification method of buying commodities because of the fixed belief that many manufacturers work off "seconds" on such customers. The knowledge that they can at any time, when they so desire, call upon testing laboratories to check the deliveries made to them on contracts, based on specifications with which certificates have been issued by the manufacturers, will induce a large number of such purchasers to take full advantage of the certification plan.

COLLEGE RESEARCH LABORATORIES

It has seemed desirable to supplement the list of commercial testing laboratories with a complete list of the laboratories in colleges. These laboratories are used not only for purposes of instruction, but also to a considerable extent for research work. In fact, many important industrial research problems are being solved in the college laboratories.

In almost all of the college laboratories a certain amount of commodity acceptance testing is being done on either a commercial basis or for the purchasers of the States, municipalities, public institutions, or the colleges themselves. However, there is a very wide diversity in the methods of conducting such work with special reference to the responsibility of the colleges for the tests made in the laboratories.

In connection with the list of college laboratories, which is to be interpreted as showing merely that each laboratory listed is equipped to test the types of commodities indicated for research and instructional purposes, it is suggested that public purchasers and other persons interested in ascertaining whether or not commodity acceptance testing will be undertaken by certain colleges, and the conditions under which such testing will be carried on, communicate directly with the proper officers of the colleges or with the individuals in charge of the laboratories.

Altitude-Pressure

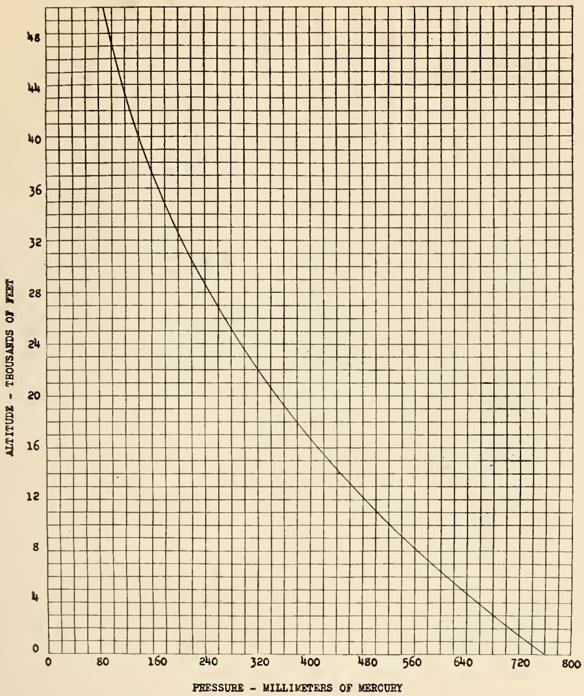

FIG. 1.—*Standard for altimetry*

Air pressures for all altitudes up to 50,000 feet for the United States standard atmosphere. These depend on a scientifically chosen altitude-temperature relation

Calorimetry

FIG. 3.—*Standard for heat of combustion*

(Pure naphthalene $C_{10}H_8$)

Acidimetry

FIG. 2.—*Standard for acidity measurement*

(Pure benzoic acid, C_6H_5COOH)

36316—27——26

Colorimetry

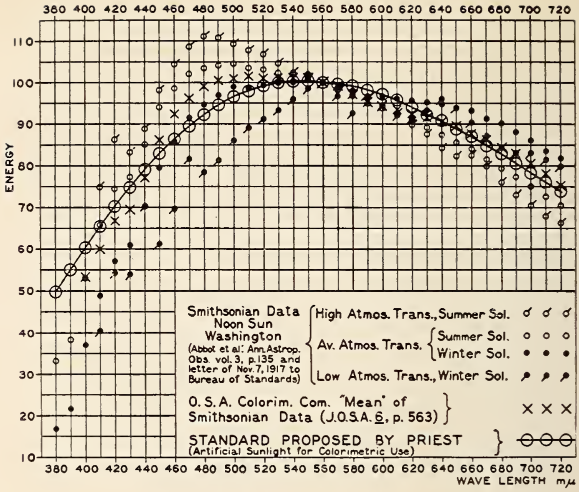

Fig. 4.—*Standard of color*

(Standard sunlight)

Densimetry

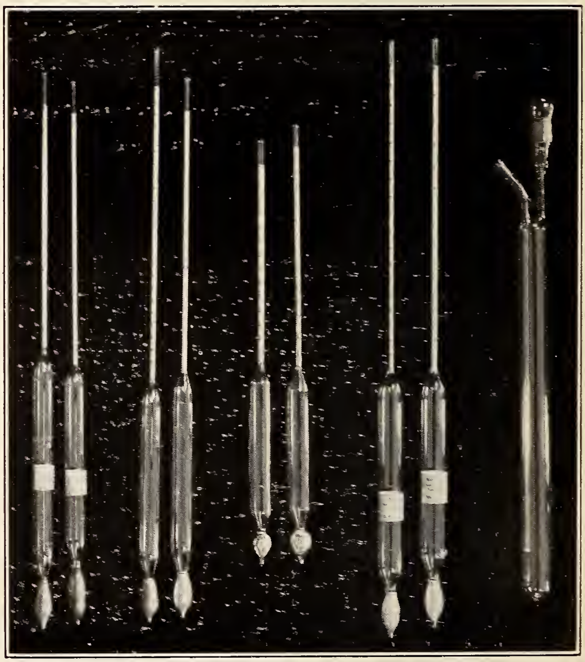

Fig. 6.—*Working standards of density for liquids*

(Hydrometers and picnometers)

Composition

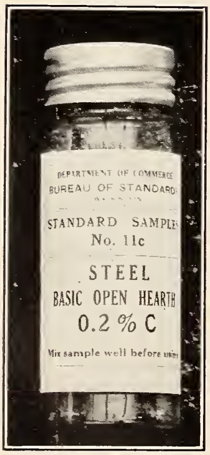

Fig. 5.—*Standard for quantitative analysis*

(Basic open-hearth 0.2 per cent carbon steel)

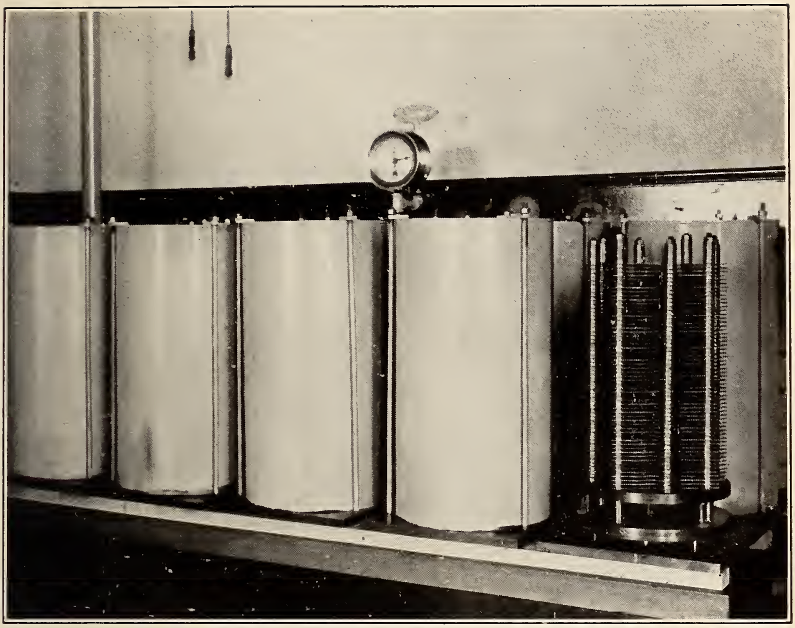

FIG. 7.—*Standard of electrical capacitance*

(The farad)

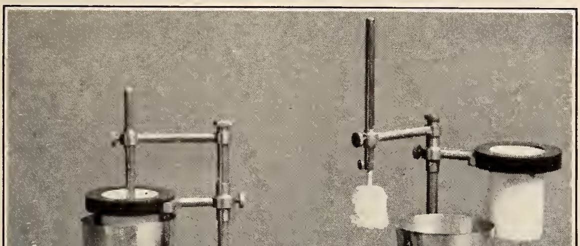

FIG. 8.—*Standard voltameter for measuring electric current*

(The ampere)

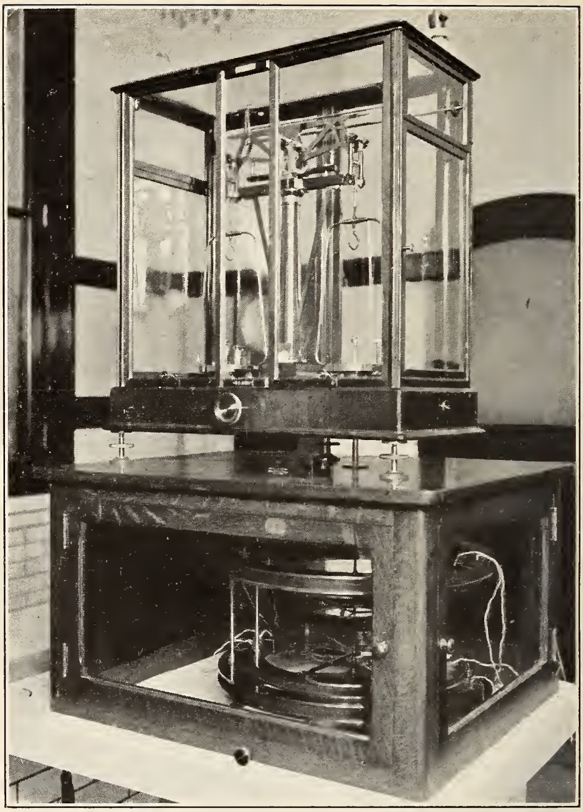

FIG. 9.—*Standard of electric current*

(The ampere)

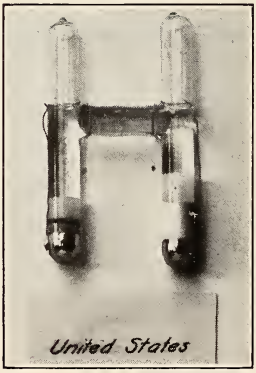

FIG. 10.—*Standard of electromotive force*

(The volt)

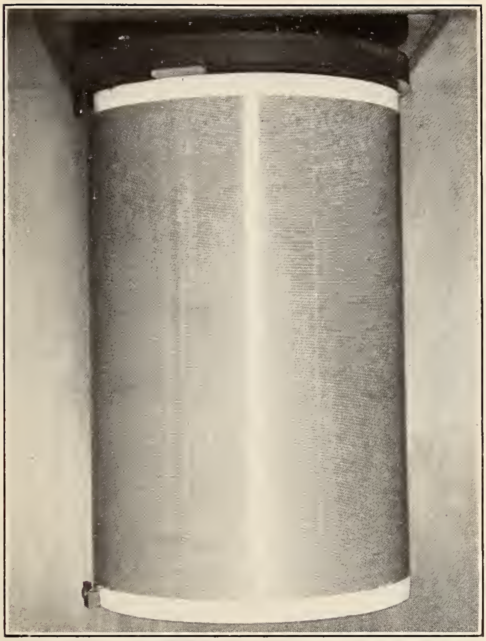

Fig. 11.—*Standard of electrical inductance*

(The henry)

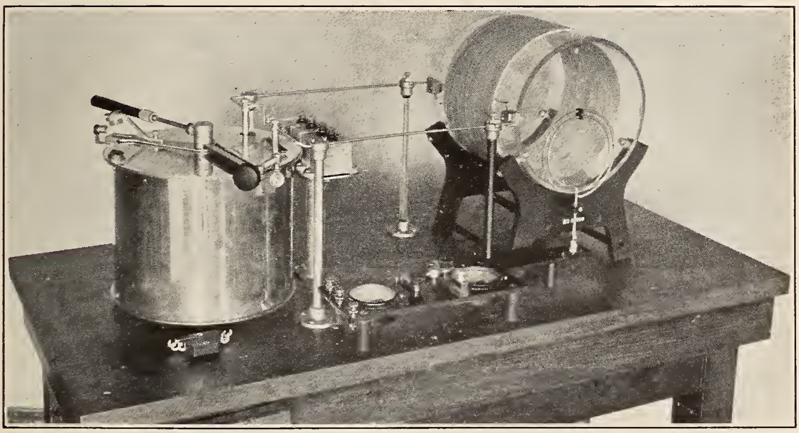

Fig. 12.—*A standard of radio-frequency*

(Wave length of radio waves)

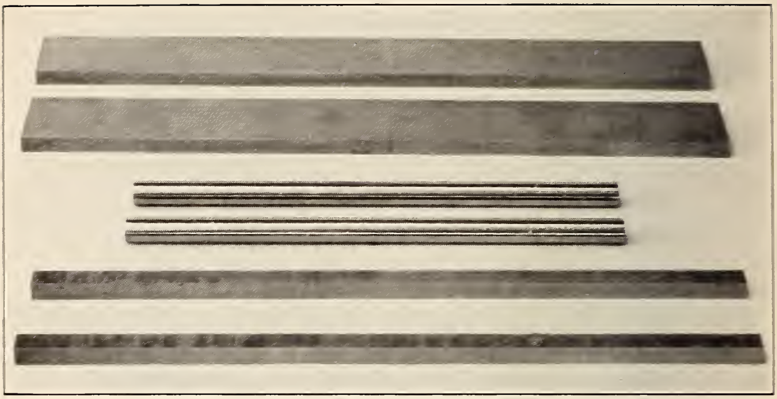

FIG. 13.—*Standards of magnetic permeability*

(Typical standard magnetic test bars)

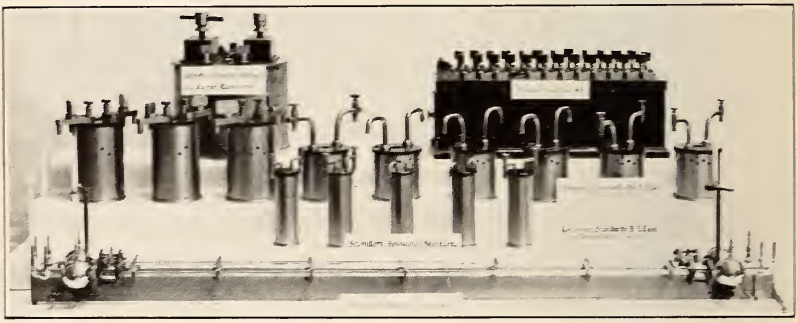

FIG. 14.—*Standards of electrical resistance and the standard mercury ohm*

(The ohm)

FIG. 15.—*Latest forms of inclosed electrical resistance standards*

(The ohm)

Frequency

(See also Time, fig. 22, and Radio Frequency, fig. 12)

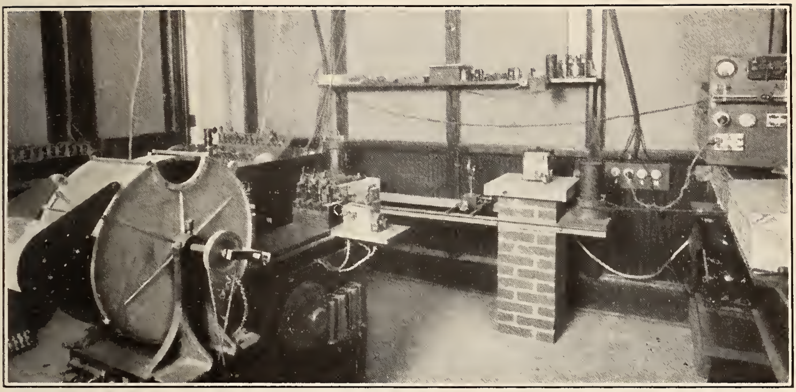

FIG. 16.—*Working laboratory standard*

(Pendulum oscillations)

Frequency

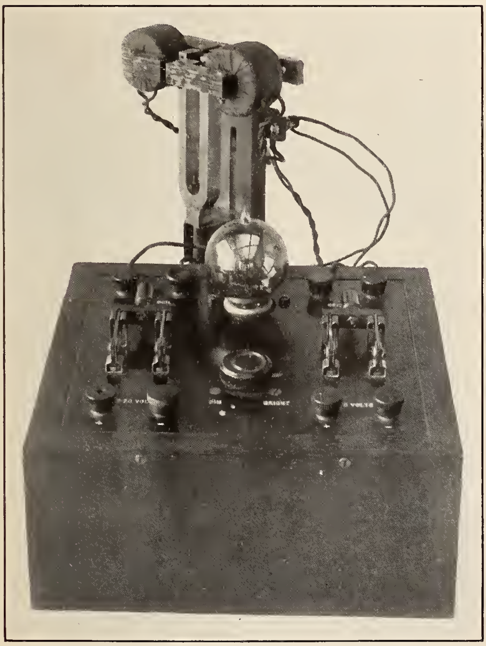

FIG. 17.—*Working laboratory standard*

(Tuning-fork vibrations)

Grain Size

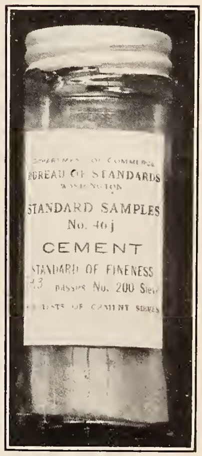

FIG. 18.—*Working standard of fineness*

(Portland cement)

Fig. 19.—*Standard of length*

(The meter)

Mass

Fig. 20.—*Standard of mass*

(The kilogram)

Volume

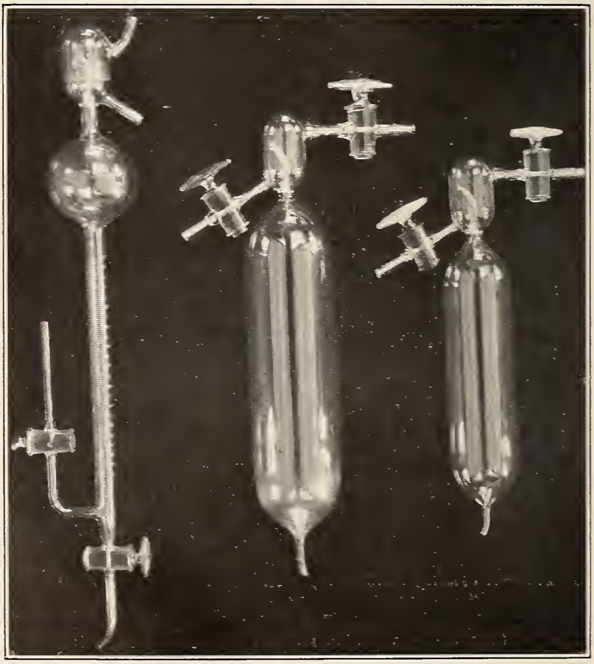

Fig. 21.—*Standard of volume*

(Liter and other units of capacity)

FIG. 22.—*Standard of time*

(Precision clock)

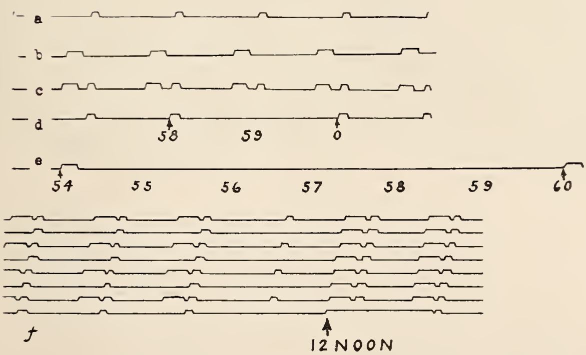

FIG. 23.—*Chronograph records of time*

(*a*) Notches recording seconds (bureau clock)
(*b*) Notches recording seconds (Arlington)
(*c*) Simultaneous records of (*a*) and (*b*)
(*d*) Record showing omission of fifty-ninth second to mark end of minute
(*e*) Record showing omission of five seconds preceding the noon signal (Arlington)
(*f*) Record showing the noon signal recording a notch one second in length (bureau and Arlington)

Polarimetry

Oxidimetry

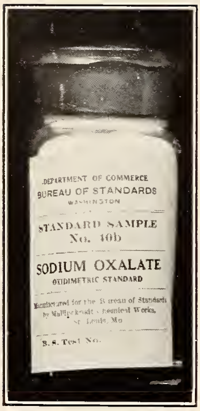

Fig. 24.—*Oxidimetric standard*

(Pure sodium oxalate, $Na_2C_2O_4$)

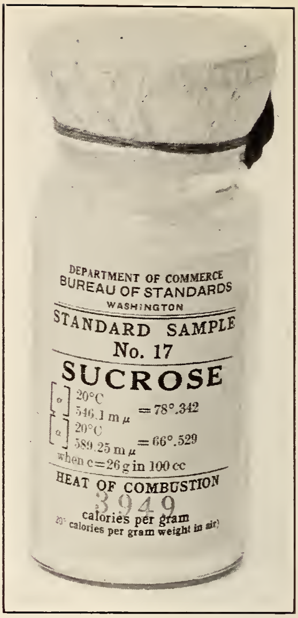

Fig. 25.—*Standard for optical rotation*

(Pure sucrose, $C_{12}H_{22}O_{11}$)

Photometry

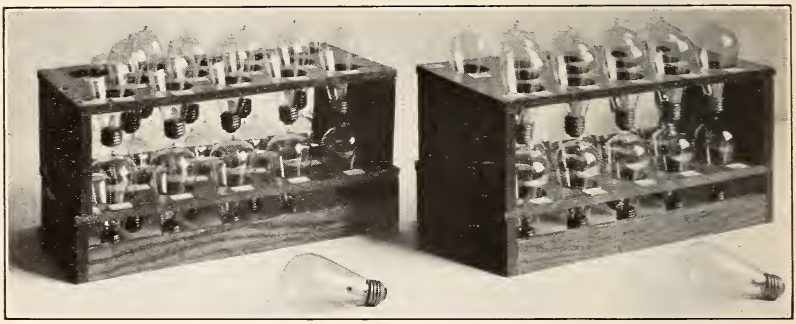

Fig. 26.—*Standards of luminous intensity*

(Candlepower)

Planometry

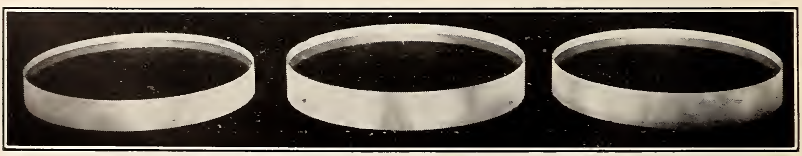

Fig. 27.—*Standard of planeness*

(Quartz flats)

Polarimetry

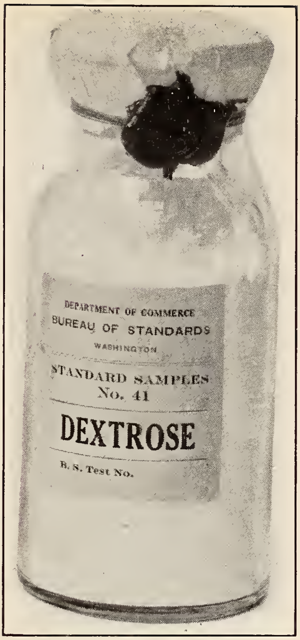

Fig. 28.—*Standard reducing substance*

(Dextrose, $C_6H_{12}O_6$)

Pyrometry

Fig. 29.—*Standards for temperature fixed points*

(Freezing points)

Radiology

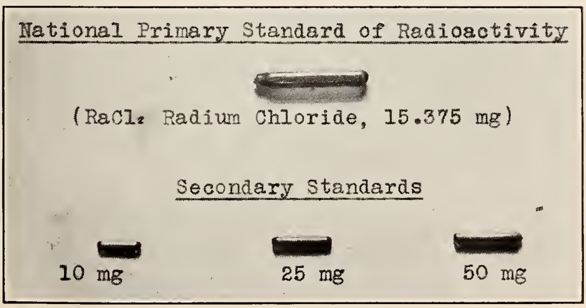

Fig. 30.—*Standard of radioactivity*

(Radium chloride, $RaCl_2$)

Radiometry

Fig. 31.—*Standard of total radiation*

(Radiant energy)

Saccharimetry

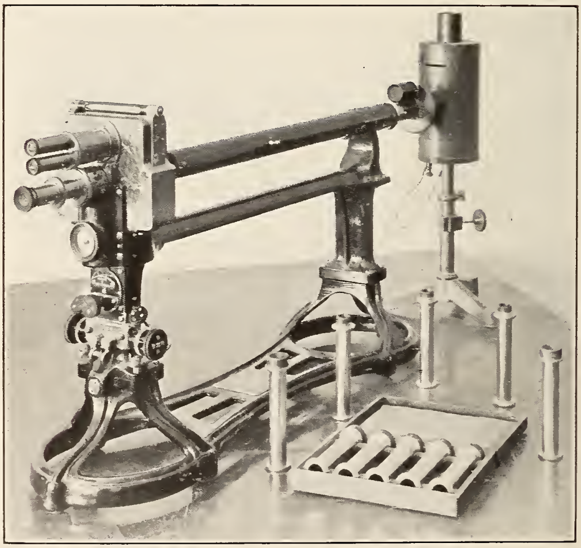

Fig. 32.—*Standard for optical rotation*

(Quartz-control plates)

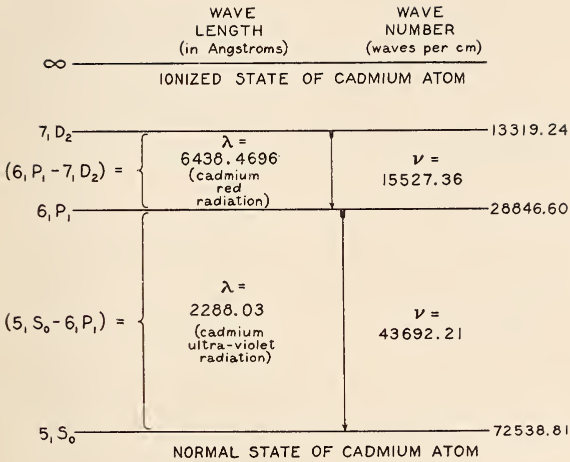

FIG. 33.—*Energy levels (wave numbers) involved in the electron movement (small arrow) which causes the cadmium atom to radiate the standard red light (see line at the right, fig. 34) used to define the angstrom unit*

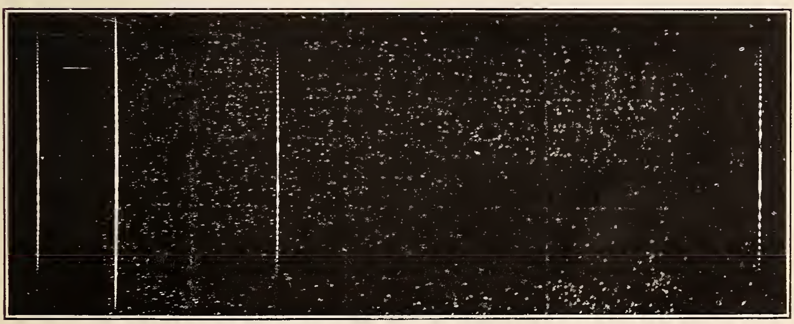

FIG. 34.—*Standard for wave-length measurements*

Visible spectrum of cadmium showing (at right) the red line, the wave length of which is used to define the angstrom unit

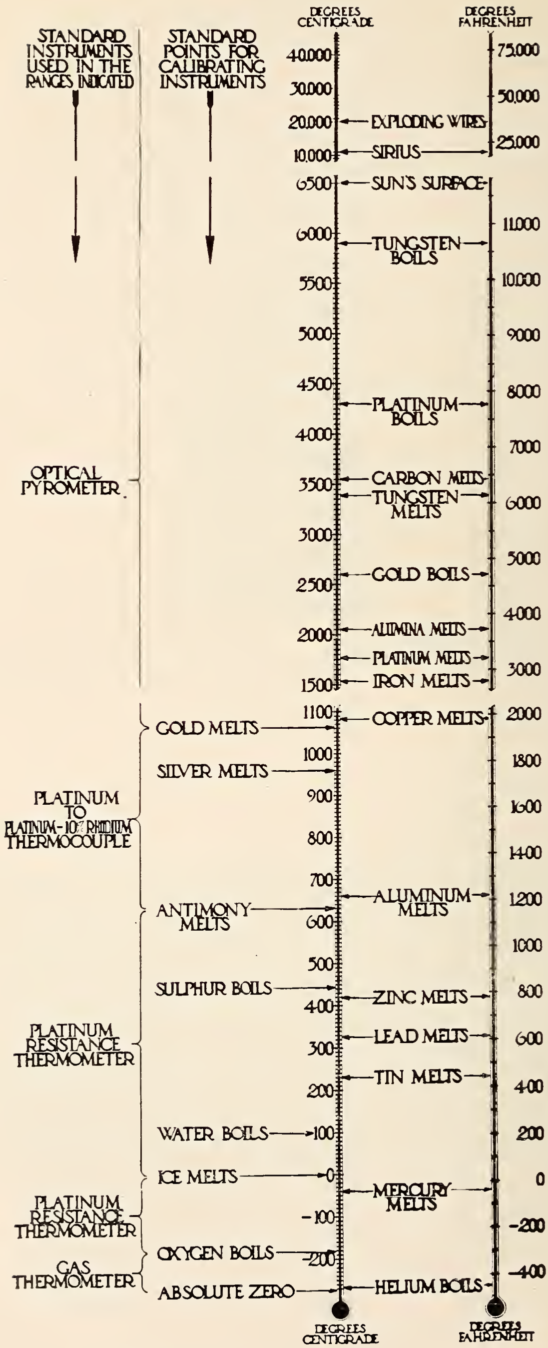

FIG. 35.—*Standard temperature scale*

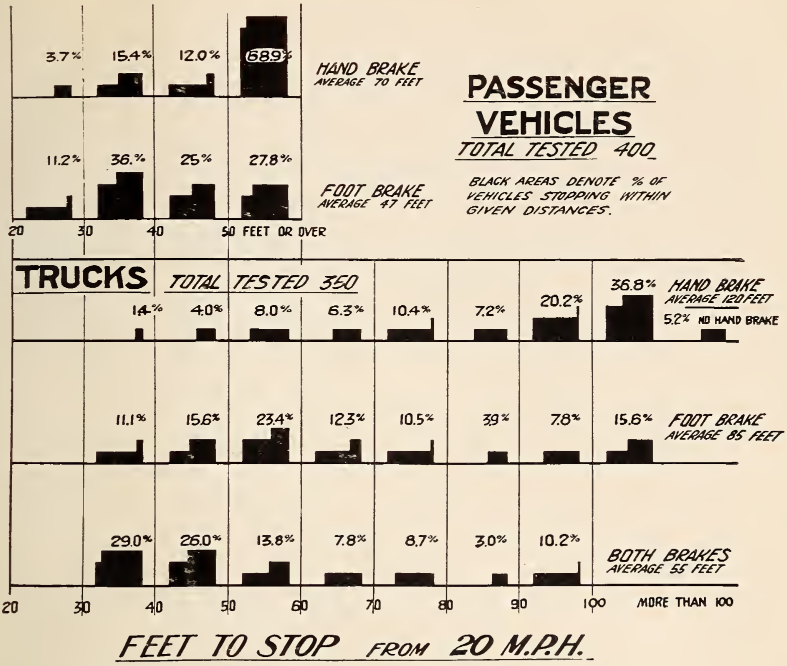

FIG. 36.—*Braking performance of motor vehicles*

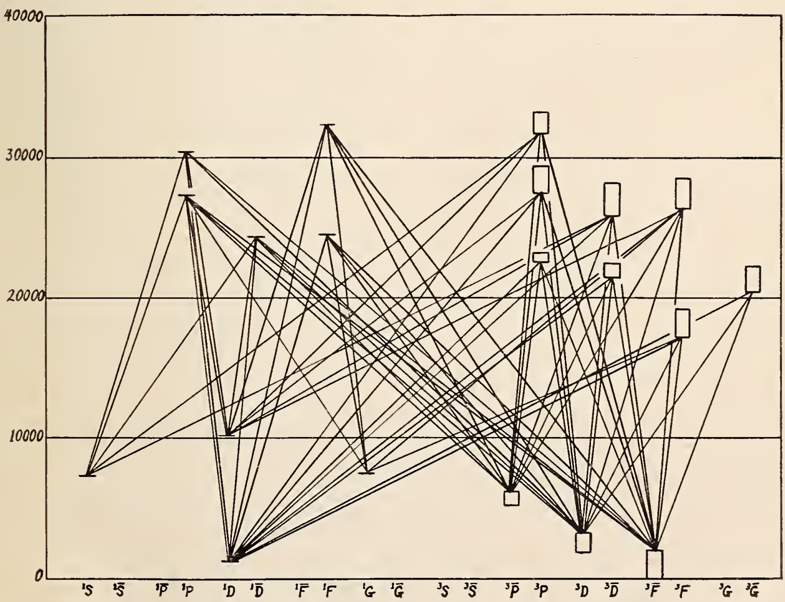

FIG. 37.—*Energy levels and combinations in the LaII spectrum*

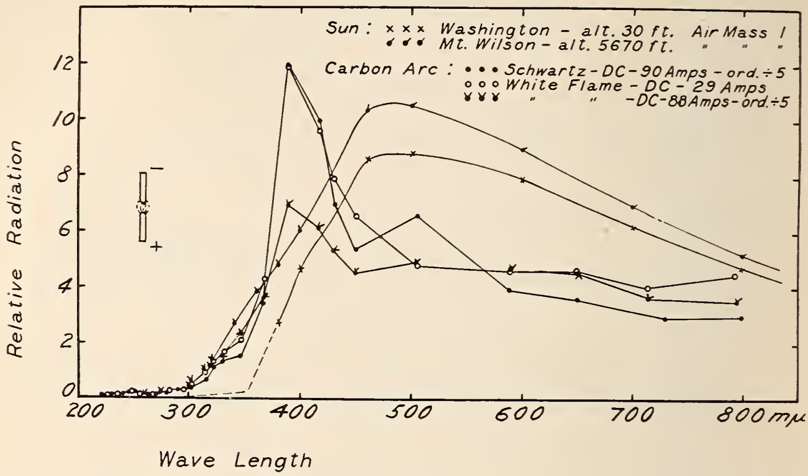

FIG. 38.—*Distribution of radiation from the sun and different carbon arcs*

The different curves are brought within the same plot by employment of arbitrary multiplying factors

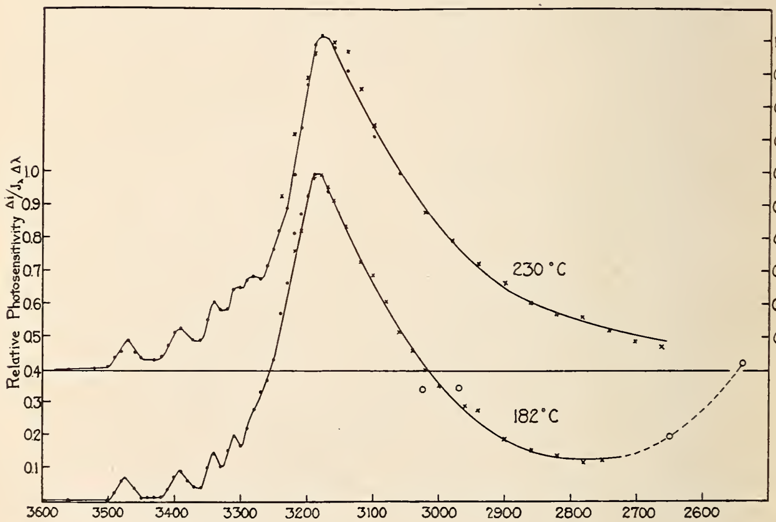

FIG. 39.—*Photoelectric effect in caesium vapor reduced to an equal energy spectrum*

The part of the curve to the right of the maximum measures the primary effect, the serrated part on the left results from ionization by multiple excitation